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Laboratory of Industrial Management
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A Study on the Economics and Financing Alternatives of Transport Infrastructure Production

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Helsinki University of Technology **Abstract of Study**

As Public-Private Partnership (PPP) activity has increased as a means of organizing the production of major infrastructure assets and services in the economy globally, it has attracted increasing attention among scholars. However, given the relatively recent introduction of PPP schemes, there is not as yet a substantial body of academic literature on such projects. Nevertheless, a number of key questions have emerged, namely: The differences in private and public sector cost of capital, the relative efficiency of public and private sectors, and the proper distribution of risk and rewards between the two.

This study contributes to knowledge in the scope of PPP in the Finnish transport sector by subjecting the two first concerns to a multi-disciplinary study, grounded in the theories of industrial organization and investment, project business literature, research on project finance and public procurement legislation. The research methodology can be characterized as building of qualitative theoretical constructs through logical, inductive reasoning.

There are three main results: The first is a unified economic model of PPP that captures the basic nature, key parties, cash flows, dynamics and uncertainty involved in a PPP project. The second is an analytical result, which shows that the difference in private and public sector cost of capital is simply a consequence of the implicit costs of public finance customarily omitted from analysis. Third, the study explicates five positive propositions explaining the comparative economic advantages of PPP relative to traditional paths of transport infrastructure procurement.

The implications of these results are essentially two-fold: First, the result that sovereign finance is not cheaper than private finance, when both implicit and explicit costs are considered, suggests that the cost-efficiency of the PPP is higher than customarily assumed. Second, a theoretical analysis of the rationale for incorporating traditionally segmented, fixed-fee, short-term contracts under a single, long-term performance-based concession, shows that this creates opportunities for economies of scale and scope, investment in specialized capital and contractual mechanisms that contribute to minimizing both production and transaction costs relative to traditional procurement. These, in turn, suggest that the PPP market is attractive from a total welfare perspective, and can be expected to grow, given a political acknowledgment of the benefits of PPP and subsequent political promotion.

Teknillinen korkeakoulu **Tutkimuksen tiivistelmä**

Julkisen ja yksityisen sektorin kumppanuus, joka Suomessa tunnetaan elinkaarimallina, on yleistynyt merkittävien infrastruktuurisidonnaisten palvelujen tuottamisen organisointimuotona. Ilmiö on kerännyt yhä enemmän tutkijoiden huomiota, mutta ottaen huomioon elinkaarimallin uutuuden ei aiheesta vielä ole merkittävästi akateemista kirjallisuutta. Eräitä avainkysymyksiä on kuitenkin noussut esiin, nimittäin: Ero julkisen ja yksityisen puolen pääomakustannuksissa, julkisen ja yksityisen sektorin suhteellinen tehokkuus, sekä riskien ja tuottojen jako julkisen ja yksityisen toimijan kesken.

Tämän työn panos tutkimustietoon Suomen kuljetus- ja liikennesektorin puitteissa on alistaa edellisistä kysymyksistä kaksi ensimmäistä perusteelliselle poikkitieteelliselle tarkastelulle, nojaten toimialan talousteoriaan, investointiteoriaan, projektiliiketoiminnan kirjallisuuteen, projektirahoituksen tutkimukseen, sekä julkisten hankintojen lainsäädäntöön. Tutkimusmenetelmää voi luonnehtia loogiseen, induktiiviseen päättelyyn perustuvaksi, laadullisten teoreettisten konstruktioiden rakentamiseksi.

Tutkimus johti kolmeen olennaiseen tulokseen: Ensimmäinen on taloudellinen malli, joka huomioi elinkaarimallin keskeisimmät piirteet, osapuolet, kassavirrat, ajassa etenevän luonteen sekä epävarmuuden. Toinen on analyyttinen tulos, joka osoittaa, että ero yksityisen ja julkisen puolen pääomakustannuksissa on yksinkertaisesti seuraus julkisyhteisön pääoman implisiittisistä kustannuksista, jotka on tyypillisesti jätetty tarkasteluissa huomiotta. Kolmas on erittely viidestä tekijästä, jotka selittävät elinkaarimallin suhteellista kustannustehokkuutta verrattuna perinteisiin liikenneinfrastruktuurin hankintamalleihin.

Näillä tuloksilla on olennaisesti kahtenaiset seuraukset: Ensiksi, havainto, että julkinen rahoitus ei itse asiassa ole halvempaa kuin yksityinen, kun niin implisiittiset kuin eksplisiittiset kustannukset otetaan huomioon, merkitsee että elinkaarimallin kustannustehokkuus on vielä parempi kuin on perinteisesti oletettu. Toiseksi, teoreettinen tarkastelu osoittaa, että perinteisesti hajanaisten, kiinteähintaisten, lyhyen aikavälin sopimusten kokoaminen yhden, pitkän tähtäimen, suoritusperusteisen konsession alle tarjoaa mahdollisuuksia mittakaavakustannusetuihin, investointeihin erikoistuneeseen pääomaan, ja sopimusmekanismeihin, jotka toimivat yhdessä niin tuotanto- kuin transaktiokustannuksia minimoivasti suhteessa perinteiseen julkiseen hankintamalliin. Nämä huomiot vuorostaan tarkoittavat, että elinkaarimallilla on edellytykset oikein toteutettuna synnyttää merkittäviä kustannussäästöjä, mikä tulisi ottaa nykyistä huomattavasti laajemmin huomioon julkisessa päätöksenteossa.

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Although the task of writing fell upon me, this study is very much a group undertaking and the outcome of frequent valuable conversations with a number of industry professionals and project business academicians. Nevertheless, none of those who contributed to the study should be held responsible for any errors, which if found, are solely my own responsibility.

I was very fortunate to have the guidance of PricewaterhouseCoopers in a study on the subject of Public-Private Partnership, for which the firm can credibly claim global leadership in terms of advisory experience. I am especially grateful to M.Sc. Vesa Salmela, who directed this study to the few key themes that the debate on Public-Private Partnership almost perpetually revolves around. I also thankfully acknowledge the research grant from PricewaterhouseCoopers Corporate Finance Finland.

I would also like to convey my most sincere thanks especially to Ph.D Jaakko Kujala and Professor Karlos Artto at Helsinki University of Technology. They not only provided some profound theoretical insights, but – with good cheer – an encouraging company to work with.

I am also grateful to the rest of the team and the supervisory board at the Incopro research project, which initiated my own interest in the subject of Public-Private Partnership. The project also provided an opportunity to gain basic familiarity with the construction industry, as well as develop the foundations for this study, in terms of both knowledge and contacts.

Helsinki, 30 May 2006

Jarkko Murtoaro

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1 INTRODUCTION

In this chapter the basic approach of the study is described. The chapter is divided into five sections. The purpose of the first section is to demonstrate the relevance and novelty of the research. The second section states more formally the identified gap in knowledge and the purpose of this research in the form of explicit research questions and objectives. The third section presents the constraints by which the scope of the study is narrowed. The fourth section describes the methodological approach of the study. The chapter concludes with a description of the overall structure of the study.

1.1 Background

The investment and productivity challenge faced by governments in the development and modernization of transport infrastructure is a focus for Finnish and European public policies.[1] Public-Private Partnership (PPP) projects are increasingly accepted as a viable approach to the procurement and delivery of major public infrastructure assets and related services.[2] There is evidence of strong PPP deal flow in a number of countries within Europe, increasing adoption in countries with previously low levels of PPP activity, and shared interest in the project model across the region.[3] As is the case with any new phenomenon on the verge of taking off, backers are pressed to justify, defend and win acceptance of their actions, and therefore PPP is subject to significant debate in Finland as well.[4]

Given the relatively recent introduction of PPP schemes, there is not as yet a substantial body of academic literature on such projects. There are multiple industry reports and surveys on PPPs, but they are typically directed at a non-academic audience and lack a rigorous theoretical foundation.[5] Nevertheless, the quantity of relevant literature is increasing

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[1] European Commission 2003
[2] European Commission 2004
[3] Dealogic ProjectWare 2005
[4] See e.g. Helsingin Sanomat 2006, Kauppalehti 2006
[5] See e.g. Davies & Eustice 2005, Rakennusteollisuus 2002

and a number of key questions have emerged, namely: The differences in private and public sector *cost of borrowing*, the *relative efficiency* of public and private sectors, *distribution of risks* between the government and a private supplier, and *value for money considerations*.[6] These concerns have not been subjected to a theoretically well-founded study and are therefore a relevant and novel focus for research.

1.2 Research Problem

PPPs are complex arrangements and knowledge on the subject cuts across multiple knowledge domains including economical, financial, and legal disciplines. This research is mainly concerned with an economic analysis of two of the two key concerns that have emerged in multiple industry reports, surveys and a growing body of academic literature on PPPs, namely: the differences in private and public sector *cost of borrowing*, and the *relative efficiency* of public and private sectors.[7]

It seems possible to trace and link both of these considerations to the explicit and well-founded conceptual frameworks of industrial organization and investment theory. This theoretical background and the associated conceptual tools help develop a better and deeper understanding of the nature and rationale of PPP, as well as the key concerns that have emerged in literature.

There are three, largely self-standing research problems, which can be stated and justified as follows:

Research question 1: What is PPP?

The notion of Public-Private Partnership is by no means simple. The scheme involves a government, a private company and some major capital investment project. It is not self-evident why centralized government

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[6] See e.g. Franks 2002

[7] Value for money considerations essentially study *productivity*: the *ratio* of benefits to costs. In fact, value for money considerations coincide with efficiency considerations, when either benefits or costs are held constant, and differences in the free variable are studied.

involvement is necessary in the first place, since most economic goods are produced and priced through decentralized interaction in markets. Similarly, some economic activity is typically organized centrally by the government. It is important to inquire into why should both public and private sector involvement be desired, and what roles they play, respectively. The basic nature, key parties, cash flows, ownership, and so forth are basic concerns that need to be addressed for any further study to proceed. Economic theory provides a robust framework for achieving this understanding.

> *Research question 2: What are the differences in private and public cost of capital?*

Financing is one of the most important functions in PPP, and a key theme in the literature on PPPs. Differences in the costs of debt service between the private and public sector are a recurrent topic of debate in research as well as media. The typical argument is that a government can save on debt service costs relative to private companies due to an excellent credit rating. However, debt service costs are only the explicit costs of capital, whereas a comprehensive economic perspective also includes implicit costs that result from foregone opportunities – the opportunity costs. Prior studies have not embraced this economically sound view, which is why the cost of capital deserves a separate elaboration in this study.

> *Research question 3: What factors encourage organizing the production of transport infrastructure through a PPP?*

PPP is a relatively novel means of organizing the production of transport infrastructure and stands in rather stark contrast to traditional paths of public procurement, which is why PPP is subject to significant debate in Finland and elsewhere. Although its rationale can ultimately be answered only through empirical studies, a number of arguments against PPP have been developed, based on primarily hypothetical calculations. A theoretically well-founded study is thus warranted to develop clarity and in-depth understanding of PPP, and to provide a strong foundation with

which to evaluate the validity of hypothetical calculations, as well as to guide further empirical research.

Again, it seems that prior studies have not embraced an economically comprehensive view, which foremost distinguishes between, and accounts for both direct production costs, as well as transaction costs. In particular, due to the economic nature of infrastructure goods, transaction costs and the contractual mechanisms designed to mitigate them seem to play a more significant role than research has customarily recognized. For example, costly quality problems that result from inappropriate contractual mechanisms, which allow a supplier to opportunistically deviate from agreed specifications are captured in the concept of transaction costs. For another example, under certain contracting practices a supplier may have no interest to voluntarily exert effort that is costly, but which would result in much higher life-cycle cost savings – the difference is again captured in transaction costs. The basic point is that a narrow focus on production costs fails to account for long-run cost inefficiencies which arise from inappropriate contracting practices.

1.3 Research Objectives

The research questions engulf a wealth of literature and cross disciplinary boundaries. The basic challenge is one of gathering information in these domains, developing deep understanding of the subject, investigating what is relevant in it, interpreting it from the perspective of PPPs and finally processing it into a communicable format.

It is customary to distinguish between five types of objectives in scientific research.[8] First, research may seek to *problematize* taken-for-granted knowledge in the first place. Second, research may strive to produce a *description* of a phenomenon or object. Third, an objective of research may be to produce an *explanation* of the causalities related to a phenomenon. Fourth, research may want to use descriptions of phenomena

[8] Niiniluoto 1980

and explanations of causalities to *predict* the consequences of changes in factors related to the phenomena. Finally, research may seek to provide a *prescription* as to what action should be taken, which involves making an essentially non-scientific *value-judgment* as to what is desirable.

The first research question is what is a PPP?

> *Objective 1: Produce a* description *of PPP, based on a profound economic understanding of transport infrastructure production, complemented with insights from project business literature, project finance research, and public procurement legislation.*

The second research sub-question is what are the differences in the costs of private and public capital?

> *Objective 2: Produce an* explanation *of the differences in public and private cost of capital, based on the theories of industrial organization and investment*.

The third research sub-question is what factors encourage organizing the production of transport infrastructure through a PPP?

> *Objective 3: Produce an* explanation *of the comparative cost advantages of PPP, reduced to an economic description of infrastructure production, and the concepts and results provided by the theory of industrial organization*.

1.4 Research Scope

The research questions in this study are cross-disciplinary, addressing the domain where PPP as a form of project business, project finance, the economics of infrastructure goods, and legal frameworks overlap. PPP can be conceived as a form of project business and a distinct mode of organizing the delivery of major capital investments.

Therefore the overarching discipline in this study is project business, although the analysis primarily relies on the excellent conceptual tools of

industrial organization and investment in its approach. This is not unconventional, since being primarily a practical discipline and lacking its own basic theory, project business study draws from multiple theoretical backgrounds.[9] Nonetheless, this makes it particularly important to narrow down the scope of the research through a set of precisely specified constraints. The main constraints whereby the scope of this study is focused, and validity ensured, are driven by primarily practical motivations as follows.

The decision to focus on PPPs is based on evidence, which suggests the model is becoming more established in Finland and elsewhere across Europe, with the UK market reaching already a level of maturity.[10] The model has proven its efficacy under certain circumstances world-wide, and although Finland has been slow in its adoption, the domestic market for PPPs is expected to grow in the near future.[11] Local construction companies as well as public authorities have demonstrated considerable interest in the market as exemplified, for instance, by the commission of a number of research initiatives.[12]

The decision to focus on capital-intensive transportation infrastructure projects is justified by the fact that in Finland, like elsewhere, the first major PPP projects are developed precisely in the transport sector.[13] The Finnish PPP model best conforms to the model denoted by *BOT* in the US and *PFI/DBFO* in the UK.[14] In these models a separate legal company is established and the sources of project funds are overwhelmingly private. The term capital-intensity is used to refer to projects where a significant commitment of capital is necessary for the provision of the service, which, in turn, contributes to the importance of financing.

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[9] Artto & Wikström 2005
[10] Salmela 2005
[11] Kaislanlahti 2001
[12] For instance, Life-cycle Initiative at VTT, and InCoPro Research Project at BIT research center
[13] The first ”authentic” PPP deal in Finland, the E18 Lohja-Muurla highway was closed in 2005.
[14] Jokela 2002

Given the relatively recent introduction of PPP schemes, there is not as yet a substantial body of academic literature on such projects. There are multiple industry reports and surveys on PPPs, but they are typically directed at a non-academic audience and lack a rigorous theoretical foundation. As already noted, this research is concerned with two specific concerns that have emerged: the differences in private and public sector *cost of borrowing* and the *relative efficiency* of public and private sectors.

For a common, unified treatment of these concerns, a consistent, accepted and fundamental theoretical framework is warranted. For this purpose, the research chooses to rely on the theories of industrial organization and investment, which seem to provide excellent and profound conceptual tools to facilitate the study. Moreover, they both draw from the same background: economics. Investment theory is often characterized as applied economics, and industrial organization is a branch of microeconomics that conforms to the ideas of optimizing behavior and the common motive of cost-minimization. In fact, they are both based on the paradigm of rational decision making, applied to industrial markets and financial markets, respectively.

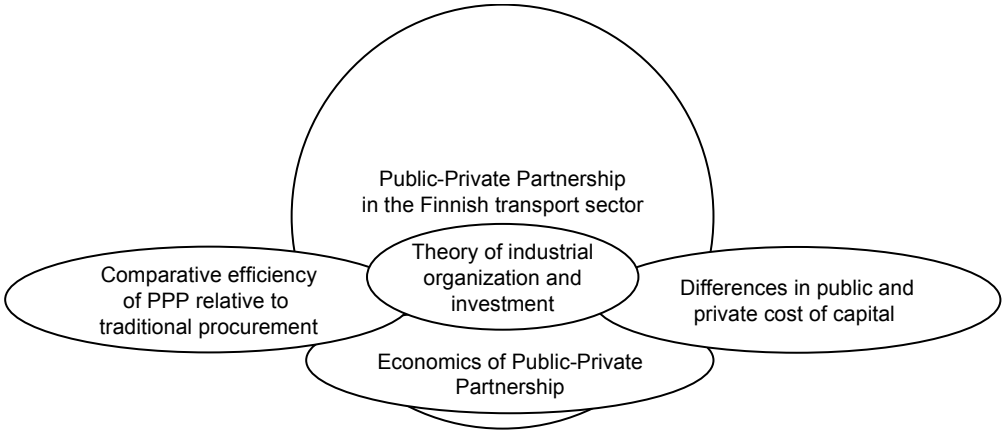

Figure 1 A schematic representation of the scope of the study

This theoretical background helps to describe in subsequent chapters the rationale of PPP, its distinctive characteristics and the two key concerns that have emerged in literature. The theory of industrial organization and investment theory therefore serve to inquire into the empirical context of

PPP and to integrate the different knowledge domains, which intersect in this study. The figure above (Figure 1) gives a simple schematic representation of the scope of the study, the main concerns and the main theories applied.

1.5 Research Methodology

This research is carried out within the tradition of industrial engineering and management (IEM) in Helsinki University of Technology (HUT), under the guidance of International Project Business -professorship. In the classification of sciences, research in IEM is positioned as applied science. The purpose of applied science is to serve as a bridge between basic science and practice.[15] As applied science, IEM aims at practical results applicable in industry.[16] With reference to this research tradition, the purpose of this study is to ground the study of PPP in the Finnish transport sector to the basic theories of industrial organization and investment, and produce novel knowledge applicable within the Finnish economy.

General research characteristics that are valued at IEM are *relevance*, *contribution* and *evidence*.[17] Relevance means high priority in the domain of business problems and potential value for practitioners. Contribution means novelty of the research findings among the research community and positioning the findings in an existing body of knowledge. Evidence needs to be based on both empirical data and rational reasoning.

In this study, relevance is derived from the growing role of PPP in addressing the investment and productivity challenge faced by governments in the development and modernization of transport infrastructure in Finland and Europe. Contribution is sought by subjecting two of the key concerns related to PPP to a theoretically well-founded, structured study. Evidence, in turn, is gathered primarily by inductive,

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[15] Niiniluoto 1980
[16] Olkkonen 1993
[17] Eloranta 1998

logical reasoning of the key concerns within established theoretical frameworks.

At IEM, deep understanding of the phenomenon as a research result is valued[18] which is why the dominant research method has been empirical case study research.[19] Deep understanding means explanation of potential 'how' and 'why' questions of the phenomenon under study. The empirical context in this research is selected using theoretical sampling, i.e. the empiric focus is chosen for theoretical, not statistical reasons.[20]

Although this study lacks a particular empirical case study, the research approach is not purely theoretical, because the empirical context of inquiry is well defined. Deep understanding of PPP in the transport sector is sought by translating the empirical phenomenon to fundamental conceptual frameworks, which allow producing 'how' and 'why' explanations to the research questions, in the form of theoretical constructs.

It can be argued that sound theoretical constructs are a prerequisite for later empirical case studies. In other words, some profound theoretical effort is required to guide more empirical analysis of the particularities of the Finnish regulatory environment, construction industry and government agencies, and so forth. Yet, the objective even of this study is not to arrive at results, which can be readily generalized to other variations of PPP initiatives and industries; instead, to direct attention to the unique conditions prevalent as defined in the research scope.

An important feature of this research is also the overlap of information collection, analysis and interpretation, which together form an iterative process, similar to the one employed in case studies.[21] The process starts by definition of the research questions and selection of the relevant

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[18] Ranta 1999
[19] Eloranta 1981
[20] Eisenhardt 1989
[21] Glaser & Strauss 1967

concepts, which in this study are grounded in the theories of industrial organization and investment. The principles and concepts of these theories are used to direct attention to what should be studied in order to answer the research questions, as suggested by Yin.[22]

The sources of information, and their relative standing utilized in this study can be divided into literature, which is the primary source, and authorities who provide secondary information. The literature consists of academic research articles and textbooks on the theory of industrial organization, investment theory, project business, project finance, public procurement legislation and PPPs. The main authorities, which the study relies on, can be divided further into two: First, industry representatives, who can be considered as credible authorities on the infrastructure industry, financial advisors and corresponding legislation; and second, scholars in the field of project business and finance.

The research accesses these two data sources with two distinct data collection methods. The use of multiple sources and data types, i.e. triangulation, provides stronger substantiation of argumentation; moreover, combination of data types can also be highly synergistic.[23] The process is essentially iterative, but begins with a literature study carried out in order to establish the necessary basic understanding and terminology of industrial and financial theory. The second data collection method involves interviews with open-ended questions based on the literature study in order to provide qualitative data on the subject, i.e. to verify, substantiate and validate the analysis utilizing the expertise of practitioners.

1.6 Structure of Report

This report is divided into eight chapters. In Chapter 1, the basic approach of the study is described, claiming the novelty and relevance, defining the research questions, objectives and scope, and characterizing the methodological approach and structure of the of the study. In Chapter 2,

[22] Yin 1989
[23] Jick 1979

the main theoretical background of the study is reviewed, introducing the basic principles and concepts, which are necessary for the articulation and analysis in the subsequent chapters. In Chapter 3, the Public-Private Partnership scheme and traditional public procurement practices are reviewed from various disciplinary perspectives. In Chapter 4, the economic fundamentals of transport infrastructure production are analyzed, and the traditional paths of public procurement as well as PPP are characterized on basis of the theory of industrial organization. In Chapter 5, the differences in public and private cost of capital are analyzed, based on the same theoretical background. In Chapter 6, the comparative efficiency of PPP relative to the traditional path of procurement is analyzed, grounded mainly in the theory of industrial organization. In Chapter 7, the key results of the study are summarized, with a separate section dedicated for each of the research questions and results. Finally, in Chapter 8, the practical relevance and theoretical contribution of the results are discussed and reflected against prior research as well as industry practice; the reliability and validity of the study is assessed; and avenues for further research are suggested.

2 THEORETICAL BACKGROUND

In this chapter the primary theoretical background of the study is reviewed, introducing the basic principles and concepts, which are used in the subsequent chapters for articulation and analysis. Although project business is the overarching body of knowledge in this study, the discipline typically draws from multiple theoretical backgrounds. The complexities and recurrent themes in the study of PPP warrant a theoretically well-founded methodology, for which the theories of industrial organization and investment seem best suited. The idea is to review these theories first, so as to gain freedom to apply their concepts and ideas freely in subsequent chapters. If an audience encounters unfamiliar concepts in the main body of the study, it is encouraged to refer to this chapter. The chapter is divided into two sections, with the first one focusing on the theory of industrial organization, and the second focusing on investment theory.

2.1 Theory of Industrial Organization

2.1.1 Core Definitions

Definition of Industrial Organization

Theory of industrial organization is a branch of microeconomics, which focuses on the study of how firms make themselves as well of as possible in a world of scarcity and the consequences of those decisions for markets and the entire economy. Theory of *industrial organization* is also known as *producer theory* and the terms are used synonymously in the study.[24] The basic structure of the theory's review here is divided into two parts, of which the first focuses on various views to the *notion of the firms,* as compositions of economic activities, and the second part on the *behavior of firms,* first as a unitary optimizing entities, and subsequently from the contracting perspective of multiple unitary, but interacting optimizers.

[24] The key ideas are denoted in italics

The theory, like any science, employs various models to approximate reality and focus the study on only the critical aspects of a given phenomenon or object. Industrial organization uses, in particular, mathematical expressions relating two or more quantitative terms to make explicit assumptions that elevate an analysis to a higher level of abstraction and allow the use of standard mathematical techniques. It is customary to distinguish between *positive and normative models*: Positive models simply present a cause-effect relationship, but refrain from taking any prescriptive stance as to what is desirable, which is the role of normative inquiries. Finally, it should be noted that the theory in this chapter is widely accepted, and the contributors are so many that references are mostly omitted. The primary sources that this study draws from are Tirole,[25] Jehle and Reny,[26] and Perloff.[27]

Methodology of Industrial Organization

In historical retrospective, modern producer theory owes to two research traditions of which the first is sometimes called the *Harvard tradition*. This tradition was empirical in nature and developed the famous *structure-conduct-performance paradigm*, according to which market structure (the number of sellers, their degree of product differentiation, etc.) determines conduct (price, R&D, advertising, etc.) and conduct yields market performance (efficiency, profits, etc.).[28] This approach, although plausible, was mainly informal, rested on loose theories and produced what is best defined as descriptive statistics.

The second tradition, which was mainly theoretical, adopted *non-cooperative game theory* as a unified methodology for the study of market structure and firm behavior, where the elegant and general analysis of competitive markets was inapplicable. Furthermore, serious progress of the concepts of *dynamics* and *asymmetric information* allowed formalizing

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[25] Tirole 2002
[26] Jehle & Reny 2000
[27] Perloff 2001
[28] Bain 1954

many of the informal insights of the earlier Harvard tradition.[29] The core of the modeling methodology is the assumption of *optimizing behavior*, and firms are treated as single unitary decision makers that maximize profits. Problems of managerial control by shareholders or bankers are typically assumed away, but are sometimes enclosed in the analysis through *principal-agent models*, which build on asymmetric information and, again, optimizing behavior.[30]

Producer theory methodology, in the line of the second tradition, customarily starts with models of *monopoly*, where a firm encounters a passive environment absent of competitors. The model of monopolistic competition is extended into models of *oligopolistic market* competition, where multiple separate firms behave in their own *self-interest*. If the number of firms in markets is increased to infinity, the models of oligopolistic markets coincide with the *competitive-equilibrium* model; the best-developed and most applied model in producer theory, and in fact, all of economics. Since this study is concerned with a PPP market, where a single buyer (the government) trades with a single seller (the project consortium) chosen from a pool of only a few potential candidates, the competitive equilibrium is hardly an accurate representation of the market. However, is seems sensible to treat in brief this model, which is highly prominent in all of economics, and provides a conceptual background against which the study of PPP can be understood.

Producers in Competitive Total Market

The competitive equilibrium model of markets starts with a description of available *economic goods*, which are characterized by their physical properties, the date, location and the state of nature on which they are available. Consumers are *perfectly informed* about all goods' properties and have preferences over bundles of goods. Producers, i.e. firms, are owned by consumers and endowed with *production possibility sets*. A

[29] Tirole 2002
[30] See e.g. Arrow 1985

paradigm of a passive market organization is then added. All market participants are *price takers*. The consumers *maximize their welfare*, given that their expenditures must not exceed their income, which gives rise to *demand functions*, i.e. correspondences of several well-fare maximizing bundles. Producers *maximize profits* over their technological possibilities, captured in *production functions*, giving rise to *supply functions*. Within this setting, a competitive equilibrium is a set of prices, with associated demands and supplies, such that all the markets, one for each good, clear, i.e. *total demand matches total supply*.[31]

The assumptions of the competitive equilibrium model strongly limit the scope of its application. Among the conditions that are required is the *absence of externalities* between economic agents. An externality arises when a consumption of a good by a buyer directly affects the welfare of another, or when a firm's production affects other economic agents. Another key condition is that *goods are of a private nature*, which rules out public goods that can be consumed simultaneously by several consumer-citizens. A third important requisite condition is that all parties have *perfect information* about goods, prices, and so forth. It seems reasonable to assert that for an accurate representation of a highway PPP, all of these conditions are in fact violated: A highway involves significant positive and negative externalities and the parties are hardly fully informed about the quality, value and cost of such a complex project.

Producers in Non-Competitive Partial Markets

Where externalities between economic units exist, where a market is concerned with public goods, where information is imperfect, and where the market is served by a small number of firms with non-negligible pricing power, a more realistic model is required. First of all, the analysis must focus on a *partial-equilibrium* set-up, in which a good, or a closely related group of goods is singled out and the interaction with the rest of the economy is ignored.

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[31] Tirole 2002

The notion of a market is not simple, however, and the definition should not be too broad or too narrow. Any good is potentially a *substitute* for another, if only in an infinitesimal way, but a single market should not be equivalent to the entire economy. On the other hand, if only perfect substitutes belong to the same market, all markets would be served by a single firm, since firms produce goods that are *differentiated*, if only in an infinitesimal way. In this study, (PPP) markets are assumed to be well defined and the interaction with the rest of the economy is ignored. This simply means that we will assume that a PPP market is a meaningful scoping and the analysis can be constrained to the main elements that comprise any particular PPP project.

Nevertheless, the important point is that to study producers is to study the functioning of markets, because producers operate within markets. A market is essentially an *exchange mechanism* that allows sellers to trade with buyers and therefore consists of three elements: an economic good (object of exchange), the supply side (sellers) and the demand side (buyers). Models of markets are typically classified on the basis of the assumed number of sellers and buyers.

As already noted, a competitive market is characterized by a very large number of buyers and sellers (analytically speaking, infinitely many), who consequently have no effect on the market price alone and receive normal returns on their business. On the other extreme, a *monopoly* is a market with a sole supplier of a good for which there is no close substitute, and the seller can, within limits of regulation, set its price freely and receive abnormal returns. *Monopolistic competition* refers to a market structure in which there are multiple suppliers of slightly differentiated goods, which are nevertheless such close substitutes that the sellers enjoy only limited pricing power, and no additional firm can enter and earn abnormal returns. *Oligopolistic competition* is a market with only a few suppliers of a good, and the sellers compete on price, cost structures, production techniques, product characteristics and advertising to earn abnormal returns. On the demand side, the key distinction is a *monopsony*, where there is only a

single buyer of a good in a given market. Finally, in a *bilateral monopoly*, there is only one relevant buyer and one relevant seller.[32]

The firm is the basic object of producer theory, and the focus in the following sections is on various fundamental views to the firm. This theoretical background helps to describe with conceptual clarity the rationale of PPP, its distinctive characteristics and the key concerns that have emerged in literature. Although the focus is on the firm, the views address the three basic economic questions that are at the core of producer theory, markets and more broadly microeconomics: Which goods and services to produce (the economic good), how to produce (the supply side) and to whom (the demand side).

2.1.2 The Notion of Firms

Dimensions of the Firm

The notion of a firm is by no means simple, and consequently it has been given various definitions in literature; yet, they all share the idea that a firm should be able to produce (or sell) more *efficiently* than would its constituent parts separately. It is customary to distinguish between the horizontal dimension of a firm, which refers to the scale and scope of production, and the vertical dimension, which refers to the extent to which goods and services that can be purchased from outsiders are produced in house. *Horizontally integrated* thus describes a firm that produces multiple related products, or one that has internalized several activities that accompany the production of a single product. *Vertically integrated* refers to a firm that participates in more than one successive stage of the production or distribution of goods.

There are three established definitions of a firm: the *technological*, the *contractual*, and the *incomplete contracting* one. The definitions are in fact complementary views on what determines the size of a firm along the vertical and horizontal dimensions, and all three are based on the motive of

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[32] Perloff 2001

cost-minimizing organization of economic activity. The three views can also be seen as successive stages on a research continuum, which begins with a static conception of a firm that is next complicated by the inclusion of the time dimension, and finally by the inclusion of uncertainty and admittance of limits to human rationality. It should be noted that there is a fourth tentative definition of the firm, which complements the three others with an informal social perspective, and all four will be elaborated and summarized in what follows. These views are important to study, because they provide profound insights as to why it might make sense to set up PPPs in the first place.

Technological View of the Firm

The first, technological view represents the classical, economical view of the firm, and focuses on the synergy between different production units at a given time to exploit *economies of scale* or *of scope*. Roughly, economies of scale exist when the production cost of a single unit of output decreases with the number of units produced; economies of scope are cost-savings resulting from interdependences between product lines.

In general, higher levels of production permit the use of more efficient techniques, and motivate investment in cost-reducing technologies, worker specialization and sharing of production techniques between products. For a concrete example, in a production plant with a large number of machines, the flow of output that can be sustained is proportionally higher than one with a small number of machines, because the random breakdown of one machine can be reallocated to other machines reducing the associated cost impact. Similarly, a firm serving several markets with imperfectly correlated variable demands faces less uncertainty than a collection of independent firms, and can therefore save on costly peak-load investments. The gathering of multiple activities within a firm – be they related to production, marketing, or finance – may also avoid duplication of fixed costs, or at least reduce average costs related to these functions.

The returns to scale and scope can be formalized in the concept of *subadditivity*, which requires some simple notation. Let total production

cost $C(q_i)$ represent the total cost of producing outputs q_i, where $i = 1,2,\ldots,n$. The total production cost of a firm is typically assumed to be the sum of a firm's variable cost and fixed cost $C(q_i) = c_i q_i + F$, where fixed cost F is a production expense that does not vary with output, and variable cost $VC = c_i q_i$ is a production expense that changes with the quantity of output produced. Assuming that $C(q_i)$ is the minimum cost of a bundle of inputs that allows the production of outputs $q_1, \ldots, q_n$. The cost function is then said to be strictly subadditive, if $\sum C(q_i) > C(\sum q_i)$.

Subadditivity therefore simply means that it costs less to produce various outputs together than separately, and encourages the gathering of activities within a firm. Yet this is not an ultimate conclusion, since the average cost AC of production, which is the total cost divided by the units of output produced, $AC(q_i) = C(q_i) / q_i$, typically increases at high output levels, as a result of increasing marginal costs $MC(q_i) = \delta C(q_i) / \delta q_i$, and thereby limits the size of firms. Increasing marginal costs are typically explained by the diseconomies of scale at high levels of production and higher cost of managing a larger, more complex firm that offset the scale and scope benefits.

Moreover, inherent problems with the technological view can be highlighted by two examples: First, if producing output $q_i + \delta q_i$ were to cost more than producing outputs q_i and δq_i separately, a firm could simply set up two divisions, operated as "quasi-firms" to resolve the problem. Second, it is not entirely clear why economies of scale and scope should be exploited within a single firm, since they could, in principle, be obtained through contracting with legally separate entities. For example, a firm could serve several markets with imperfectly correlated variable demands through vertical restraints specified in distribution agreements, without having to internalize the activities. Or ensure a steady supply of inputs through supplier agreements. In conclusion, the technological view basically focuses on static reasons of the firm, i.e. reasons, outside of the time dimension, why economic units might want to merge. But a dynamic

perspective must account for the possibility of contracting with other firms, which is the focus of the next section.

Contractual View of the Firm

The *contractual view of the firm* focuses on the arrangement of economic units in a *long-run relationship* to avoid *contractual hazards* resulting from *opportunism*.[33] Possibility of opportunism and contractual hazards arise when parties to an exchange must sink trade-specific investments before trading. Before agreement to trade there may be many suppliers and buyers, but once investments have been made, the parties may end up in a bilateral monopoly situation. The supplier may not find alternative outlets, and the buyer may not be able to contract with a new supplier on time. A long-term contract must *ex-post* guarantee the parties a fair return in order to *ex ante* encourage investment specific assets (as well as prohibit monopoly pricing).

For simplicity, the review will focus on a vertical relationship between a supplier and a buyer, and both parties are assumed to be risk-neutral, which means that they are indifferent between a certain outcome and a fair bet, with expected value equal to the certain outcome. Long-run relationships are associated with *idiosyncratic investment* and *resulting asset specificity*. Idiosyncratic investment is associated with the prospect of future trading that exploits the use of specialized assets. This is the case, for instance, when a supplier must design equipment, the characteristics of which are specific (dedicated) to a buyer's particular order, or when a buyer spends resources to design a final deliverable before an intermediate good used to produce this good is delivered by the supplier. Idiosyncratic investment increases switching costs, prominent among which are the needs for a new supplier to learn the trade and the reluctance of the old to transmit information to the new one.

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[33] Opportunism refers to taking advantage of another party when circumstances permit.

Williamson[34] distinguishes two further types of specificity: *site specificity* and specific investments in *human capital*. Site specificity is associated with the gain (or cost savings) in trading with a nearby supplier or buyer. Specific investments in human capital involve, for example, the learning of production processes and managerial dedication. Nevertheless, all these types of asset specificity have the same outcome: The parties that contract now know that later on staying together can yield a surplus relative to trading with other parties. It is important that the surplus gain from trade will be exploited correctly *ex post* (after contracting) and that they will be divided properly in order to induce the efficient amount of investment *ex ante* (at contracting).

A crucial aspect of specific investment is that even though the supplier and the buyer may select each other *ex ante* from a pool of potential trading partners, they end up forming an *ex post* bilateral monopoly in that they have an incentive to trade between them rather than with outside parties. The hazard is that under bilateral monopoly, each party wants to maximize its share of the common surplus *ex post,* which jeopardizes the incentives to make efficient amounts of specific investments *ex ante,* which in turn promotes the writing of contracts.

The alternative to contracting would be to rely on *ex post* bargaining. It is important to realize that an *ex ante* contract and *ex post* bargaining are, in principle, substitutes to one another. The parties to a trade, could refrain from writing a contract *ex ante,* sink specific investments, and engage in *ex post* bargaining to decide on the distribution of the consequent surplus yields. However, when there is an *information asymmetry*,[35] bargaining may not be efficient, which stems from the fact that both parties would like to appropriate the gains from the trade, but run the risk of foregoing the trade by being too demanding. Generally, bargaining under *symmetric information* is efficient, but not necessarily equitable. In other words, the

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[34] Williamson 1975

[35] Asymmetric information is a situation in which one party knows a substantial fact relevant to a trade, which another party does not know

party with higher bargaining power, i.e. with better alternatives outside of the negotiation, may be able to capture most or all of the implied surplus yields.

The most obvious limitation of a long-run relationship is the presence of outside opportunities. Forcing parties to stick to a trade through high penalties for breach may be undesirable if there are no gains from the trade, or if better outside opportunities are available to one or both parties. The contract must therefore find an optimal trade-off between *flexibility* and the *prevention of opportunism*. In conclusion, the theory suggests that firms should write long and detailed contracts where that is feasible and not too costly, and that the incentive to do so increases with the specificity of investments and the lack of outside opportunities, to which investments can be substituted. In other words, *"a verbal contract is worth the piece of paper it is written on."*

Complete *ex ante* contracts are also known as classical contracts, and can be described as "sharp in by clear agreement; sharp out by clear performance." These contracts are associated with trades in the absence of unforeseeable uncertainty or bounded rationality, i.e. where complete specification of the object of exchange is possible.[36] The basic challenge in designing a complete contract is to exhaustively embody the expectations and conditions of an exchange relationship and creating conditions for monitoring, or alternatively inducing optimal effort through incentives. In classical contracts, there is an emphasis on the letter of agreement, the documented contract, and contingencies are clearly and narrowly defined. The result is that consequences of fulfillment or of failure are well understood from the beginning of the relationship, which is not necessarily an appropriate assumption of reality – explored in the next section.

[36] Williamson 1985

Incomplete Contracting View of the Firm

The contracting view of the firm studied organizations in terms of complete contracts. In practice, however, contracts are fairly *incomplete*, due to *transaction costs*. Coase[37] and Williamson[38] have distinguished between four types of transaction costs, two of which occur at the contracting date and two of which occur later. First, some *contingencies* may not be foreseeable at the contracting date. Second, even if they could be foreseen, there may be too many contingencies to write into the contract. Third, *monitoring* the contract and checking that the counterparty abides by its terms may be costly. Fourth, *enforcing* contracts may involve considerable legal costs. The incomplete view of the firm asserts that the minimization of transaction costs is a major concern in determining the optimal size of the firm. In order to avoid hazards in the future, parties should sign complete contracts, or, if this is impossible or too costly to write, the parties should at least make correct use of *authority*.

The incomplete contracting view thus focuses on the extent to which authority is distributed between economic units through different governance modes. Authority to choose the ways in which capital and personnel are employed is important, because contingencies unforeseen and unspecified in a contract may arise. The ownership of assets give the owner of a firm the power to make decisions that minimize costs within the broad lines of the relationship as specified in a contract.

The alternative to distributing authority instead of allocating ownership is to establish neutral arbitration mechanisms. Arbitration offers opportunities for more cooperative or interactive approaches than litigation, and arbitrators can be chosen who have a better business understanding than a judge of the transaction in question. The involvement of a neutral third party is a mechanism which promotes identifying private information of the parties and acting on it without opportunism. The

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[37] Coase 1937
[38] Williamson 1975

arbitrator is given the authority to make joint decisions should unforeseeable conditions arise.

Incomplete contracts are also known as *neoclassical* contracts. In the presence of uncertainty and bounded rationality, it can be impossible to write contracts which describe all possible contingencies. Rather than abandon the exchange altogether, or produce the good internally, the practice of writing incomplete contracts has developed. Such contracts are of long term, and include specification of mechanisms for adapting the agreement as conditions change, foremost including the involvement of third party arbitration.[39] An important difference between private arbitration and court litigation is the intention to preserve the exchange relationship.

Relational Contracting View of the Firm

In practice, however, MaCaulay[40] has found that relations between firms tend to be more *informal* than is predicted by the theory. This is true even in long-run relationships, but can be explained by the concept of *reputation*. A firm that cheats at some date, or makes decisions that are not in joint interest, runs the risk of losing future profitable deals with its partner – or with third parties, to whom the information is transmitted. Cheating or not cheating is a form of *signaling*, i.e. action taken by an informed party to send information to an uninformed party on a hidden variable. Parties may receive the signal directly or refer to other uninformed industry parties to *screen* potential trading partners, i.e. take action to determine the information possessed by an informed party. Recurring positive signals build a positive reputation.

Although, reputation is no substitute for technological synergies, it allows a firm to save on the costs of writing complete contracts or on the costs of distributing authority. On the other hand, informality exposes the firms to the threat of opportunism, and therefore informality is expected to be most

[39] Grossman & Hart 1986
[40] MaCaulay 1963

prevalent when specific investments are limited and when trade is sufficiently frequent so that the incentive to engage in opportunistic behavior is low.

Contracts may in fact damage exchange performance by undermining relational governance.[41] If one party trusts the other there is little need for exhaustively specifying actions - trust replaces contracts with handshakes. Therefore relational contracts refer to relationships, which typically include extra-legal cultural elements to foster cooperation, and include commitments not enforceable in the courts. A relational contract specifies only the general terms and objectives of a relationship and specifies mechanisms for decision making and dispute resolution, i.e. self-enforcement. They also involve informal agreements and unwritten codes of conduct that powerfully affect the behavior of the unitary parties to the trade. Complex and long-term exchange relations are sometimes impossible without a presumption of fundamentally cooperative intent foreign to the notion of litigation. Reciprocity and risk-sharing are common as tokens of good faith and trust.

Summary of the Views to the Firm

The table below (Table 1) summarizes the lessons from the various views to the firm. The logic of the representation is to show the line of thinking for each view(left side), starting with the basic conditions each view assumes and show two intermediate steps leading to the conclusion as to what means (right side) are instrumental in minimizing the costs of organizing economic activity. All of the means imply *integration* in some sense. The first, "plain" integration refers to internalizing activities within a legally separate unit. The second, complete contracts, approximates integration through contracting, and is therefore customarily referred to as quasi-integration. The third, authority, complements quasi-integration by assigning explicit decision making rights to resolve potential costly

[41] Macaulay 1963

conflicts. The fourth, reputation, entails integration of economic units within an informal social setting.

Table 1 Cost-minimizing lessons from the various views to the firm

Views of the firm	Assumed conditions	Key concepts	Key motives	Means to minimize costs
Technological	Potential for technological synergies	Economies of scale and scope	Achieve lower total production costs	Integrate activities within a unitary firm
Contractual	Possibility of engaging in a long-run trading relationship	Asset specificity	Achieve surplus yields by lower total production costs or higher value in the long-run	Design *ex ante* complete contracts that secure investments in specialized capital
Incomplete contracting	Presence of complexity and unforeseeable uncertainties	Transaction costs	Save on costs of writing contracts and avoid potentially costly future conflicts and litigation	Write incomplete contracts and design *ex ante* contract adaptation mechanisms
Relational contracting	Social embeddedness of economic activity	Reputation	Achieve lower contracting costs and secure future profits	Develop positive reputation by sending consistent signals of cooperation

The first view assumes the possibility of technological synergies that can be achieved by higher levels of output that allow exploiting economies of scale or of scope. Economies of scale and scope are motivated by a decrease in the production cost of a single unit of output (economies of scale) in a single product firm, or a decrease in the production cost of a single unit of output in a multi-product firm (economies of scope), resulting in a lower total cost, captured in the concept of subadditivity.

The second view focuses on the possibility of long-run trading relationships. Under long-run trading, it may be advantageous to make idiosyncratic investments, i.e. commit capital to relation-specific operational, human or site assets, which either decrease costs or increase value of production. Long-run trading with specific assets can yield a surplus relative to trading with other parties. The parties may be nevertheless be reluctant to make these investments, because they fear that the counterpart may take opportunistic advantage of the investments once they are committed and capture the surplus alone. To capture the benefits of asset specificity, the trading partners are therefore motivated to write contracts, which ensure that surplus gain from trade will be exploited correctly and divided properly *ex post* (after contracting) in order to induce the efficient amount of investment *ex ante* (at contracting). Theory thus suggests that firms should write long and detailed contracts where that is feasible and not too costly, and that the incentive to do so increases with the *opportunities* for specific investments and the *lack* of outside opportunities, to which investments can be substituted

The third view assumes that under complex circumstances and unforeseeable future, the contracts may nevertheless be incomplete, again discouraging investment in specific assets that could yield a trading surplus. Complexity[42] and uncertainty[43] expose the trading partners to four

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[42] Or, in reverse, bounded rationality: both are relative concepts. Under extremely bounded rationality even a simple situation seems complex.

[43] Uncertainty here refers to future events that are unforeseeable, in contrast to outcomes and associated probabilities that can be conceived in advance.

types of transaction difficulties, which may lead to costly conflicts and are therefore denoted as transaction costs. First, some contingencies may not be foreseeable at the contracting date. Second, even if they could be foreseen, there may be so many contingencies that it is too costly to write them into the contract. Third, monitoring the contract and checking that the counterparty abides by its terms may be costly. Fourth, enforcing contracts may involve considerable legal costs. To salvage idiosyncratic investment and implied surplus yields, the parties may try to avoid transaction costs by writing incomplete contracts, and *ex ante* distribute authority either to a third party, or between one another, to determine a proper course of action should conflicts arise.

The fourth view assumes that economic activity is embedded in social structures. The parties to a trade lacking a complete contract may in spite be motivated to secure and divide gains from trade properly. A social context can sustain informal relationships that allow the parties to an exchange save on the costs of writing *ex ante* complete contracts and distributing authority, when they anticipate gains from future trade that offset the gains from opportunistic behavior. A firm that cheats at some date, or makes decisions that are not in joint interest, runs the risk of losing future profitable deals with its partner; or even third parties, to whom the information is conveyed. Firms therefore seek to build a positive reputation to save on contracting costs and to secure future profits.

2.1.3 The Behavior of Firms

Profit Maximization Hypothesis

The most common assumption regarding the behavior of firms is that they *maximize profits*, but there are many ways in which business decision makers may deviate from this hypothesis, as well as many mechanisms that may limit managerial discretion. The shareholders of a firm are claimants for its revenue, net of various input costs. Thus, if they were able to run the firm, they would choose courses of action that would minimize costs and maximize profit. Non-profit maximization is mainly associated with the *separation of ownership and control* – the key concern of

principal-agent theory. Reviewing the principal-agent literature comprehensively is beyond the scope of this study, but some insights from the theory seem to warrant attention. First, however, we need to describe the profit maximization hypothesis, from which agents may deviate.

If output is the quantity q produced, and revenue R is the price p of goods sold times the quantity, $R = pq$, then profit π is the difference between revenues R and costs C, $\pi = R - C$. The total production cost of a firm is typically assumed to be the sum of a firm's variable cost and fixed cost $C = VC + F$, where fixed cost F is a production expense that does not vary with output, and variable cost $VC = cq$ is a production expense that changes with the quantity of output produced. Hence, profit can be written as $\pi = pq - cq - F = (p\text{-}c)q - F$. With reference to this expression, firms maximize profit π, by maximizing the unit price p, minimizing unit cost c, maximizing output q, and minimizing fixed cost F.

Transaction costs

With reference to the profit maximization hypothesis, it is essential to distinguish between two fundamental types of costs: First, those paid for an economic good (inputs or outputs, depending on the actor perspective); and second, those incurred beyond the *price paid* for the good, termed as *transaction costs*.[44] The former is simple to understand; the latter is somewhat more difficult since it includes all the other costs related to *planning, executing* and *completing* an economic exchange. Because the concept is highly important, but far from simple, it warrants some additional elaboration.

In an ideal world, where economic actors were fully informed and trustworthy, they could simply place orders on one another and receive the goods that maximized their welfare given budget constraints. However, given that real people are not fully informed, they have to search for

[44] A typical way of illustrating the concept intuitively is by drawing an analogy between economics and natural physics, and conceiving *transaction costs* as the economic equivalent to *friction* in physics.

information on the availability of goods, their characteristics, and their prices; moreover they have to decide on the least costly means of accessing this information in the first place, and so forth. Nonetheless, given sufficient information, people could, in principle, subsequently engage in economic exchanges, where one receives a good and the other something (usually money) in return.

But often the prices of goods are not fully determined, and most importantly, people are not strictly benevolent by nature, so they may not respect their commitments. Consequently, the parties to an exchange have to first engage in costly bargaining, and second, in costly drafting, monitoring and enforcing of contracts that ensure their vested interests are protected. Bargaining involves two aspects: the surplus value that a possible trade implies, i.e. efficiency, as well as the distribution of the surplus value, i.e. equitability.

Drafting contracts that embody the joint agreement gained through bargaining involves four aspects: the specifications explicit in a contract, the observation of the actions of the counterpart, the verification of these observations; or alternatively inducing action through incentives, observing and verifying the actions and thereby sharing net benefits; and finally, enforcement of verified observations, or arbitration of non-verifiable observations.

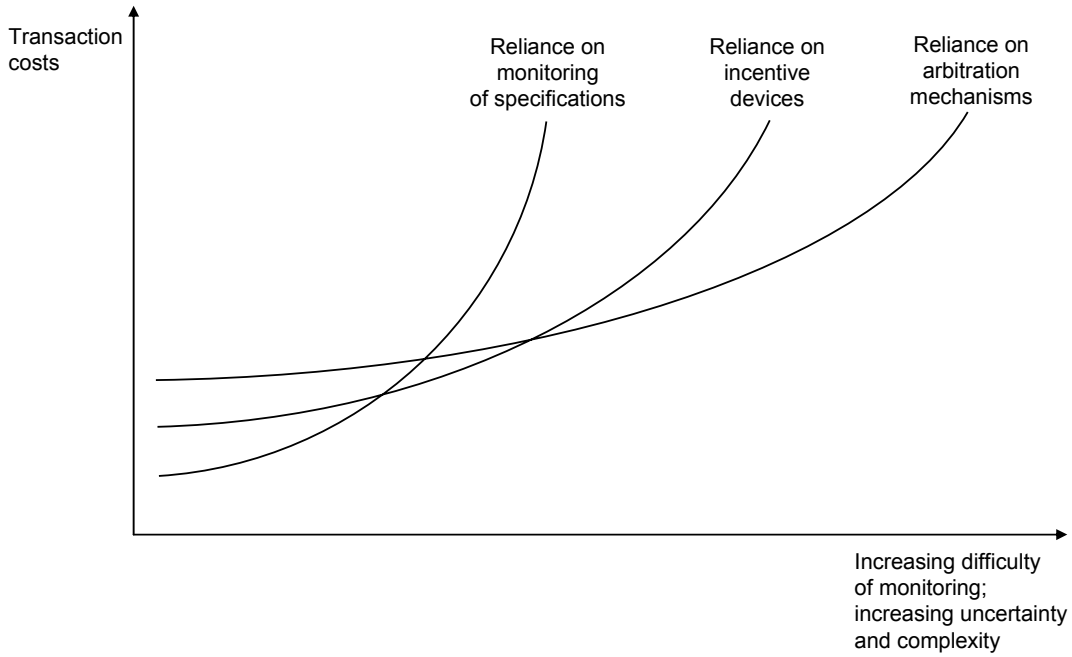

Figure 2 Illustration of the transaction costs associated with alternative contracting paths under progressively more challenging circumstances

The point is that, in principle, some costs in addition to prices paid for goods are unavoidable – known as transaction costs. However, the common motive of minimizing costs still applies, and there are alternative contracting paths that can be followed to minimize transaction costs (Figure 2). Foremost, the costs of contracting need to be weighed against the yields of a better trade, but this evaluation can be broken down into components. *Monitoring, incentives* and *arbitration* are contract mechanisms for handling progressively greater interdependence of the parties under progressively more difficult monitoring, more complex and uncertain circumstances at minimum cost.[45]

The costs of crafting more detailed contracts (along with observation of effort, verification, enforcement) have to be weighed against the possibility and costs of inducing the same effort by incentives (along with observation of output, verification, enforcement); *or* the costs implied by assuming

[45] Williamson 1985

ownership or employing arbitration mechanisms (along with observation or authority).

Nonetheless, the basic idea is that the parties to an economic trade are willing to bear transaction costs, although basically unnecessary, to capture the benefits of trading – when those benefits *offset* the higher transaction costs. Thus, it is essential to consider the fundamental, underlying benefits implied by any potential economic activity and then to evaluate whether or not they outweigh the (minimum) transaction costs involved.

Opportunity costs

Another important cost concept related to the profit maximization hypothesis is *economic cost*, also known as *opportunity cost*.[46] An opportunity cost is defined as the value of the best alternative use of a resource. It is therefore different from the explicit production expenses, and refers to the foregone opportunity to which the resources used for the production of any particular output could have been used. This idea gives rise to the concept of economic profit, which is defined as the revenue generated minus the opportunity cost of the resources sacrificed to generate the revenue. A firm can thus create a negative economic profit, although the total of revenues minus direct production costs is positive. This means that a firm must always consider the best uses of its resources to make an economic profit; the value of a foregone opportunity must be equal to, or lower than the revenue generated by any chosen use of resources.

Let us formalize this idea using some simple notation. Suppose the firm can commit its resources in a given time period to serving two different markets, *M1* and *M2*. Moreover, suppose the firm produces the same quantity q of a good, incurring the same variable cost c and fixed cost F, regardless of which market it serves, and it is able to sell all of its output.

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[46] The classic anecdote signifying this concept is: "There is no such thing as a free lunch." Even if someone pays for your lunch, the lunch is not without cost – you could have spent the time working and earning a wage. The foregone earnings are your opportunity cost.

However, suppose that the buyers in M1 are willing to pay *P,* for the good, and buyers in market M2 are willing to pay only *p,* where $P > p$.

The firm could thus make a profit of $\pi_1 = (P - c)q - F$ in market *M1*, and a profit of $\pi_2 = (p - c)q - F$ in *M2,* where $\pi_1 > \pi_2$. If the firm chooses, for some arbitrary reason , such as plain management ignorance, political pressure or social loyalty to serve market *M2* solely in some given period, it will incur an opportunity cost *OC*, defined by $OC = Pq$, which is the revenue from *M1* it chooses to forego. Although the firm makes a positive plain profit, it actually makes a negative economic profit π_e, defined by *revenue minus opportunity cost,* $\pi_e = pq - Pq = (p - P)q < 0$, since $p < P$. Its resources are not in the best use

We have already distinguished between two fundamental types of costs, those paid for an economic good, and those beyond the price paid for the good, termed transaction costs. With reference to the profit function let us assume for a while that transaction costs are zero, which allows us to distinguish between two more basic cost concepts: *Explicit costs* are the direct payments for inputs to the production process during a given time period. *Implicit costs* are inputs to the production process that are not necessarily paid an explicit price for. The opportunity cost *OC* includes both explicit *EC* and implicit costs, *IC*, i.e. $OC = EC + IC$. Then, since the firm's explicit costs are $EC = cq + F$, its implicit costs are defined by $IC = OC - EC = OC - (cq + F) = Pq - cq - F = (P - c)q - F$.

Externalities and Property Rights

The profit maximizing behavior of firms may also create *market externalities,* which are assumed to be absent in perfect markets. An externality is the direct effect of the actions of a firm on another party's well-being or a firm's production rather than an indirect effect through changes in market prices. A *negative externality* is a harm that one firm inflicts on others, and a *positive externality* a benefit that a firm provides to others. *Internalizing* an externality refers to bearing the cost or to capturing the benefit that one party inflicts on others.

Economic activity may therefore benefit (harm) other parties, but a producer may not be able to capture (forced to bear) those benefits (costs) privately. A situation where a firm is not be able to capture positive externalities privately, may lead to a *market failure*. A market failure occurs when the aggregate of private revenue and positive externalities (*social revenue*) exceed the aggregate of private cost and negative externalities (*social cost*). Producers may not find a market attractive, but the society, at large, would benefit if certain goods were provided. This is why the government, in its role as a *social planner* typically intervenes in the market to ensure that such a good is produced, either by producing the good by itself or contracting out to ensure its production. These concepts are important, because a PPP market is typically concerned with private market failure and consequently involves the direct presence of the government.

It is therefore essential to distinguish between private and social costs. Private cost refers to the cost of production only, not including externalities, where as social cost is the private cost plus the cost from externalities. The same logic applies to revenues and profits, so that private revenue refers to the private income, not including externalities, and social revenue to private income plus the benefits from externalities; and profit is the net value of revenues and costs, respectively.

According to the *Coase Theorem* externalities arise from the lack of *property rights*, which is an exclusive right to use an asset.[47] If no party holds a property right to an asset, be it good or bad, it is unlikely to have a price or a cost. For multiple goods property rights are not clearly defined, which is why a producer's private cost of production is less than the social cost, or the private revenue is less than the social revenue, i.e. benefit.

The results of the Coase theorem basically show that if there are no costs to bargaining, assigning property rights results in an efficient outcome, at which social benefits are maximized. Efficiency is achieved regardless of

[47] Coase 1960

who receives the property rights; however, the allocation of the property rights affects how the joint surplus is maximized. The problem with the theory in practice is that such *Coasian bargaining* is unlikely to occur if transaction costs are high or if the parties have asymmetric information. Nevertheless, an important insight is that property rights theory suggests that the creation of a market for ownership rights results in an allocation of assets to owners who maximize efficiency in their use.[48]

Classification of Economic Goods

A classic way of classifying economic goods is thus based on whether the production creates externalities, i.e. whether there is rivalry in obtaining a given good or not; and whether the externalities can be internalized, i.e. whether it is possible to exclude a party from the consumption of a given good.[49] On the basis of this consideration, economic goods can be classified into four major categories, illustrated in the figure below (Figure 3).

First, the top-right corner signifies *private goods*, goods that entail ownership rights, i.e. they have the properties of *rivalry* and *exclusion*, so they exhibit no externalities. In contrast, a pure *public good* is a good that lacks both rivalry and exclusion, i.e. a good whose consumption by one party does not preclude others from also consuming it, such as national defense forces. The problem with public goods and externalities at large is that they motivate *free riding*: to benefit from the actions of others without internalizing the costs of production, or to harm others without internalizing the costs of production.

[48] Alchian 1965
[49] Perloff 2001

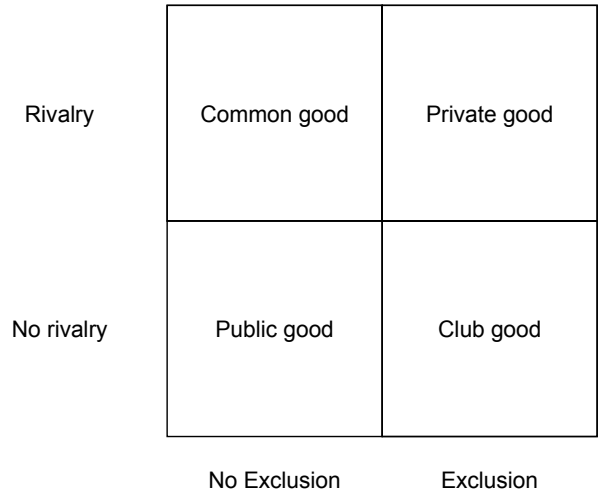

Figure 3 The classic division of goods in economics

The top left corner represents c*ommon goods*, or *common property,* i.e. goods that entail rivalry of benefits to which everyone has free access, which is why common property is typically overexploited. For example, if anyone can freely drive on a highway, too many are likely to do so, because they ignore the externalities (congestion, pollution, delays) that they impose on others. Finally the bottom-right corner entails *club goods,* goods that exhibit exclusion but no rivalry. For example, private schools or country clubs create benefits that can be internalized by multiple parties when others are excluded from accessing them.

Another essential distinction that seems to warrant attention is that between search and experience goods, originally given by Nelson.[50] A *search good* is a product or service associated with symmetric information, where a buyer can easily observe the price and quality characteristics of a good before purchase. An *experience good*, in turn, is a good associated with asymmetric information, where characteristics are difficult to ascertain in advance of purchase, but they become evident upon consumption. Again, these concepts are important for an accurate description of transport infrastructure and will be employed later.

[50] Nelson 1970

Model of Principal-Agent Relationship

A highly useful theory of analyzing more formally the interaction of multiple, unitary contracting optimizers is the principal-agent theory. The theory basically assumes that the *ownership and control of assets are separated* and that an agent controls the asset on behalf of the owner, the principal. Inefficiencies may arise, since the principal and agent may have *divergent objectives*, and the principal may not be able to *effectively monitor* the agent to ensure that the latter pursues the objectives of the asset owner. The relationship is typically discussed in the context of the separation of ownership and control between shareholders and managers. However, many of the problems and devices designed to address the problems of the division of ownership and control also apply to lower tiers of firm hierarchies, as well as trading contracts.[51]

First, it is customary to distinguish between *hidden action* and *hidden knowledge*. Hidden action refers to an agent taking some action that is unobservable by the principal, which creates conditions for a *moral hazard*: the agent takes advantage of a less-informed principal. Hidden knowledge refers to an agent having superior information about some variable. If the agent possesses the information before contracting, the setting is known as *adverse selection*; if the agent obtains the information after contracting, the setting is called *non-adverse selection*.

The most prominent principal-agent problem is moral hazard, which refers to a situation in which a principal contracts with an agent whose action is hidden, i.e. impossible to observe or evaluate. The agent may deviate from the profit maximizing hypothesis to pursue, for example, growth of output and consequent opportunities for promotion, or growth of labor input to create slack and increasing on-the-job leisure. These are example of *shirking*, a particular moral hazard, in which agents do not provide all the services they are expected and paid to provide.

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[51] Tirole 2002

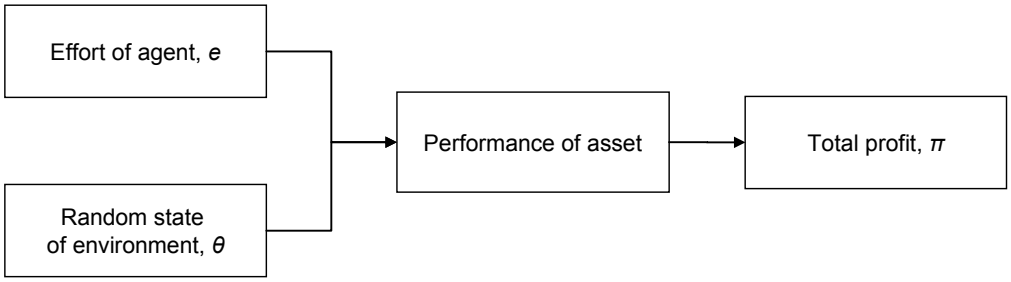

Figure 4 Model of Principal-Agent relationship

Many principal-agent models can be described and analyzed using the above model (Figure 4), which represents the *agency relationship* in terms of total profit, the efforts of the agent and uncertainty: $\pi = f(e, \theta)$, where π denotes total profit, e the agents efforts and θ is a random variable capturing uncertainty related to the total profit.

Efficiency and Equitability of Principal-Agent Relationship

If total profit were wholly independent of the agent's action, i.e. $\pi = f(\theta)$, *optimal insurance theory* demonstrates that the division of the profit between a *risk-neutral* principal (shareholders)[52] and a *risk-averse* agent (manager)[53] should have the risk-neutral party bear all the risk, and pay a minimum acceptable fixed wage w to the agent, leaving the principal with $\pi = f(\theta) - w$. However, if the profit is positively dependent on some level of effort e that is costly to the agent, the issue of *agency costs* arises.

Agency costs are deviations from profit maximization, where the deviation from total profit is greater than the private benefit that the agent gains by exerting a low level of effort. To formalize this idea, let us assume profit is fully deterministic on the agent's actions, $\pi = f(e)$ and that the agent can exert two levels of effort, high e and low e^*, where e produces high profit π and e^* produces low profit π^*. Choosing e over e^* incurs costs c for the agent, which signify all the sweat and mental exertion that accompany "trying hard." If the agent chooses low effort, and $\pi - \pi^* > c$, the relationship is inefficient. If the trade-off is equal, i.e. $\pi - \pi^* = c$, it is

[52] Shareholders are willing to place a fair bet in the capital markets, and can diversify their risk

[53] The manager is more reluctant to take on risk, because he or she cannot hold multiple positions simultaneously

irrelevant from an efficiency perspective which level of effort the agent chooses. If $\pi - \pi^* < c$, the agent should relax to ensure efficiency from a total welfare perspective.

The analysis is complicated by the inclusion of uncertainty, where profit is dependent on some random variable θ, so that total profit $\pi = f(e, \theta)$ is inherently risky. One party may differ from the other with respect to his or her attitude toward risk, so that the parties attach different *utilities* to an uncertain profit level. Therefore, it is not enough to analyze the trade-offs between $(\pi - \pi^*)$ and c; instead, the analysis must weigh $(\pi - \pi^*)$ and c by attaching risk attitudes to each monetary value resulting in *utility values*. It is therefore essential to distinguish between *technological efficiency* and *risk efficiency,* when discussing principal-agent relationships. However, although the distribution of risk can be analyzed using utility theory, we will not do so in this study; the focus is on technological efficiency, and we will assume that principals and agents have identical risk attitudes in all that follows.

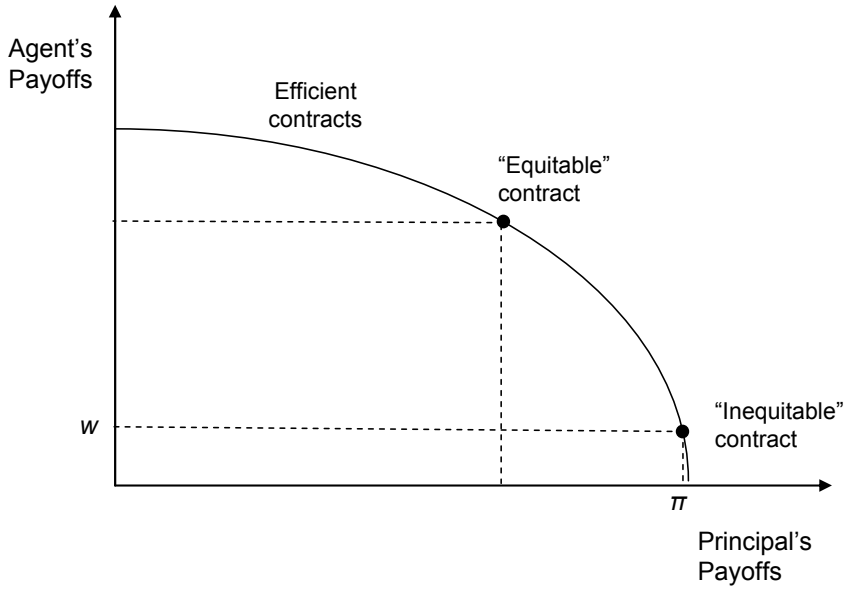

Figure 5 Illustration of the concepts of efficiency and equitability

In addition, the principal-agency theory designates that an ideal contract satisfies the condition of *equitability* (Figure 5). To achieve equitability, the trading partners should engage in negotiations or decide on a procedure

to decide on a mutually fair sharing of costs and benefits. If all costs and benefits could be estimated with reasonable confidence, analytical solutions such as the *cooperative Nash-equilibrium* could be employed to decide on an equitable, fair sharing. Where analytical solutions are not used, the parties must engage in bargaining to converge on a "gut-feel," "reciprocal" sharing of net benefits. A contract that provides one of the parties a major share and leaves the other with a minimum surplus necessary to make the trade desirable is hardly equitable, but it is up to the parties' information and negotiation skills to determine how much each captures.

Monitoring

In the absence of unforeseeable contingencies there are basically two ways to ensure efficiency in principal-agent relationships, *incentives* and *monitoring*. If the total profit is positively dependent on some level of effort *e* that is costly to the agent but *specifiable, observable* and *verifiable* by the principal, the principal could choose any level of effort he or she wants and impose it on the manager, with the threat of a large punishment if he or she disobeys. Therefore, when effort is observable, agency costs can be mitigated by monitoring, and subsequent enforcement of contracts, if necessary. However, if the profit is positively dependent on some level of effort *e* that is costly to the agent and unobservable to the principal, the issue of *incentives* arises. Where unforeseeable contingencies may rise, costly ownership rights or contract adaptation mechanisms are called for, but these are beyond the scope of the study.[54]

An important distinction relating to monitoring is between the *observability* and *verifiability* of performance (effort *e* or profit π). The distinction relates to the possibility that a principal may be able to observe the agent's or firm's performance, but cannot verify his observations to a court. When performance cannot be verified by a court, contingent contracts cannot be made, as the courts will be unable to enforce them. For

[54] There are multiple different formalized arbitration procedures, such as the combined arbitration, the two-stage final offer arbitration and the multi-stage final offer arbitration.

example, if an agent is part of a team, accounting procedures may measure the team's performance but not individual contributions. Nevertheless, an insider (e.g. a CEO) may be able to disentangle these contributions, whereas an outsider (e.g. a judge) cannot. The rewarding and incentivization of observable, but unverifiable performance can only take place through *authority*. When effort is unverifiable, even incentivization is thus insufficient and arbitration mechanisms may be necessary.

There are three common types of contract that do not employ incentives and can be represented with the basic model. First, in a *fixed fee contract*, the wage w to the agent is independent of π, e or θ, and the principal receives $\pi = f(e, \theta) - w$. The contract requires no monitoring or incentives, but may not be efficient. Second, in a *hire contract*, the agent receives remuneration based on some observable output measure e and a unit wage w, so that the principal receives $\pi = f(e, \theta) - we$. This contract requires that the effort level e is observable and verifiable. Third, in a *contingent contract*, the payoff to each party depends some random, but observable variable θ, so that the agent receives e.g. a share $s = (0, 1]$ of total profit, and the principal receives $\pi = f(\theta)(1 - s)$. This contract again requires that θ is observable and verifiable.

Incentives

If observation is impossible or too costly, the agent, if given a fixed income that does not depend on the profit, has no incentive to exert effort to maximize total profit. Effort cannot be induced by a constant wage structure so the agent's wage must grow with the realized profit. Thus the basic point is that effort, if it is not observed, must be induced through incentives. When a contract induces optimal effort through incentives, it is said to be *incentive compatible*. Incentives are typically monetary, but incentives can also consist of rewards such as prestige, promotion, recognition and so forth. *Sanctions* can be conveniently defined as *negative incentives*. Nonetheless, the sign of the incentive is uninteresting and we will discuss four types of incentives: *profit sharing, yardstick competition, hostages* and *market competition*.

Profit sharing is the most used incentive mechanism, and it typically takes the form of bonuses, based on the total performance, i.e. agent receives some share $s = [0, 1]$ of total profit, and the principal receives $\pi = f(e, \theta)(1-s)$. Another similar incentive is a stock option, which is also performance based, but dependent on the share price. The share price reflects more than periodic performance, so that managers are incentivized to take a action that maximizes future performance as well. Stock options actually also function as golden handcuffs, a form of *hostage*, because they are forfeited if the manager leaves the firm

Yardstick competition refers to an opportunity to filter out the effect of θ, from the total profit, $\pi = f(e, \theta)$ to some degree. The idea is that even if total performance π (or share price) is observable and verifiable, it may be a distorted measure of the agent's effort e, because performance may be dependent on multiple contingencies such as changes in demand or costs of inputs. These effects can be detected to some extent, by comparing the agent's performance with other agents in similar situations. The shareholders may oversee for example two similar projects that serve markets with correlated demands or costs. In this case, the shareholders can make the wages of the managers of these two projects dependent on each other. The profit of the principal is the sum of the profits from the two profits from the two projects, $\pi = \pi_1 + \pi_2$, and the manager in each project receives a wage bill based on the efforts of both managers, $w = f(\pi_1 + \pi_2) = f(e_1 + e_2)$.

When direct monitoring is costly, principals typically use *hostages* to deter undesirable behavior. Agents, who are caught shirking, not only lose their contract, but give up the hostage too. If monitoring is low so that the probability p of being observed shirking is low, but the hostage h is sufficiently high, the expected cost of shirking $s = ph$ may be high enough to offset the benefits of slack, leisure, or whatever payoff e^* shirking below optimal level of effort e allows. In other words $(e - e^*) < ph$, and the agent chooses a higher level of effort e instead of shirking. The bond can take the e.g. the form of a direct monetary post, which is typical in the

construction industry; or deferred, but anticipated future payoffs that have a positive net present value.

Market competition refers to a certain ultimate incentive, namely Darwinist natural selection. Firms that generate negative profits will be driven out of the market in the long run. Competitive firms that make inefficient decisions incur losses because they cannot simply transmit the extra costs to buyers, because the market price is taken as given. A firm is thus led to search for new and better decisions in order to survive. Firms in a competitive environment are more hard-pressed to reduce costs and end up being more efficient. For example government units, which are financed on a budget-basis, typically have low or no incentives to improve efficiency if their costs are simply covered out of tax-payers' contributions. The shareholders of a competitive firm can base managerial rewards on the competitor's profits, which would not be possible if there are no competitive references.

2.2 Theory of Investment

2.2.1 Core Definitions

Theory of investment studies the *pattern of cash flows*, and could as well be termed the theory of finance. The term investment is however favored, because finance is more of an applied theory of the same ideas to the actual discipline of corporate finance and pure investment problems. Yet, even the theory of investment is in a sense applied – the application of microeconomics within the framework of financial markets. Both fields are fundamentally grounded in the *model of rational decision making*, applied to contexts that are classified by distinctions of individual or multi-party (strategic) decision making; static or dynamic settings; deterministic or stochastic problems; and single or multiple goals. It should again be noted that the theory in this chapter is widely accepted, and the contributors so many that references are mostly omitted. The primary source that this

study draws from is Luenberger,[55] who gives an excellent, clear and concise treatment of the fundamental ideas of investment and finance.[56]

An *investment* is traditionally considered as the current commitment of resources to achieve later benefits. A broader definition views an investment as a *pattern of cash flows* in time. Every investment can be defined in terms of its resulting cash flow sequence, with individual cash flows differing in magnitude and timing. *Investment science* is the application of scientific methods and techniques to tailoring the pattern of cash flows to be as desirable as possible. *Investment analysis* is at its root concerned with examining alternative investments, i.e. cash flow sequences, and deciding which alternative is most preferable. Like economic analysis, investment analysis is therefore basically decision making characterized by optimizing behavior, with the unique feature that the decision is carried out within the framework of financial markets.

Investment theory relies in its core on four simple, but powerful principles, which provide the basis for solving most investment problems. First, the fact that investment analysis is carried within the framework of financial markets, simplifies selection by providing good outside comparables for the basis of evaluating any single investment. This condition gives rise to the first principle, the *comparison principle*.

Second, when the financial market is well developed, two different investments with identical properties will have approximately the same market price. This assumption (and empirical property) is the result of the interplay of supply and demand in financial markets reaching equilibrium, and is referred to as the *no-arbitrage principle*.

Third, trading in financial markets takes place on a continuing basis, i.e. the interaction of supply and demand is a process moving in time and

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[55] Luenberger 1998

[56] The secondary source used is Howells & Bain 2002

subject to uncertainty. This gives rise to the principle that the value of an investment may change in time, stated as the *dynamics principle*.

The fourth and perhaps most consequential one is called the *principle of risk aversion.* Cash flows are subject to uncertainty, but they may also differ in degree of uncertainty. The risk aversion principle rests on the idea that given two different investment opportunities with equal expected return, in probability terms, but of which the other is certain and the other uncertain, an investor will prefer the certain one. This means that more risk is acceptable only with a greater expected return.

Every investment problem is essentially unique, but many fit into two main categories. The first category is concerned with pricing problems. In other words, how much is a particular cash flow reasonably worth? The comparison principle is the main basis for solving the problem, and the correct, fair price can be deduced e.g. within a mean-variance setting, formalized in the *CAPM* model.[57] For example, an investor given opportunity to participate with an equity stake in a project seeks to determine how much he or she is willing to pay for that stake.

The second category deals with so called pure investment problems. In other words, where to invest available capital? The basic idea for solving this problem, in turn, is reliance on the risk aversion principle, and again a solution, i.e. an allocation can be deduced within the mean-variance setting, this time using the formal Markowitz portfolio model. For example, the analysis of potential investment projects and the capital structure of those projects take the form of a pure investment problem. Therefore at a rather high level of abstraction, companies that take capital and transform it into infrastructure, equipment, people and operations to make profit face essentially the same problem as do pension funds in the allocation of their funds.

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[57] The mean-variance setting, the CAPM model and the Markowitz portfolio model will be reviewed in Section 2.3

2.2.2 Interest Rate Theory

Interest

The assumption that a well-developed financial market exists, gives rise to the concept of the time value of money, expressed concretely as interest. Within the framework of financial markets, it is possible to deposit an initial amount, a *principal P*, which during a single time period earns an *interest i* and increases to a *future value FV*, where $FV = P(1 + i)$. The concept of *debt D* can conveniently be conceived as a negative deposit, in other words an obligation to repay the principal and interest. The calculation of the interest may vary from a *simple interest*, where the interest remains constant in subsequent periods (linear growth of principal), to *continuous compounding*, where the interest is added to the principal and a subsequent payment is based on the balance during the beginning of an infinitesimal period (exponential growth).

Present Value

A reversal of the concept of future value of money gives rise to another important concept, the *present value PV*. A cash flow received in the future is worth less than the same amount received in the present. The process of evaluating future obligations as an equivalent present value is called *discounting*. A cash flow to be received at a future date must be discounted by dividing its magnitude by the factor by which the money would grow. There is, accordingly a *discount factor d* for each future date.

Given an *interest rate r*, and a stream of cash flows $X = (x_0, x_1, \ldots, x_n)$, corresponding to discrete intervals $i = 0, 1, \ldots, n$, then the future value of the stream at the end of period n is given by $FV = x_0(1 + r)^n + \ldots + x_n(1 + r)^{n-1}$. If we were to replace that stream with a single flow in the present, it would amount the present value given by $PV = FV / (1 + r)^n$.

Two cash flows are equal if and only if their present values are equal. Since the essence of investment analysis is to choose between alternative investments, to do this intelligently they must be evaluated with a logical and standard criterion. The criterion which is generally regarded as the

single best measure is the *net present value* (NPV), which, despite the letter N, is equivalent to PV, i.e. the total sum of the discounted magnitudes of the individual cash flows of the stream. The *internal rate of return* (IRR) is another widely used evaluation criterion, and can be defined conveniently as the discount factor *d* for which the $NPV = 0$.

In business parlance, it is common to use the figure *cost of capital* (CoC) as the discounting factor. CoC is used as a measure of return a business must offer to investors, i.e. it is the *rate of return r*, which investors expect from a particular venture. The difference between an arbitrary rate of return *r* and an interest rate *i* is that *i* is used to evaluate deterministic cash flows, whereas *r* is used in evaluating uncertain cash flows from business ventures, by capturing the uncertainty in the analysis with an appropriate $r > i$, reflecting the degree of uncertainty.

Fixed-Income Securities

Well-developed financial markets employ some standardized cash flow streams, which involve obligations to pay money according to specified rules. These are called *financial instruments*, and when they are traded on a dedicated market they are called *securities*. In the case a cash flow, i.e. an investment opportunity, is neither nonstandard, nor has a dedicated market, but can nevertheless be bought and sold, it is called an *asset*.

Interest rate theory is concerned with the analysis of *deterministic* cash flows. The concept of deterministic means that the cash flows under analysis are fixed, i.e. there is no uncertainty involved in the timing or magnitude of the cash flows. Securities, which possess this property, are called *fixed-income* securities. Although the cash flows are assumed to be fixed (except for variations in well-defined contingent circumstances), in reality they are subject to some measure of *default risk*. That is, there is a positive probability that the cash flows will not realize. This risk is characterized by *default risk ratings* assigned by specialized organizations, such as Standard & Poor's, which ranks fixed-income securities into discrete classes ranging from AAA to D with increasing risk of default. Securities with a rating of BBB or above are typically called *investment*

grade, and securities ranking below BBB *junk bonds*. Securities issued by governments may lack a rating altogether, due to the assumption that they can be considered default risk free for all practical purposes. The rate of return, which certain government backed securities offer is often denoted as the *risk-free rate* r_f and is often used as a reference point in practice as well as in theory.

There are numerous standardized fixed-income securities with varying cash flow profiles. These securities have a trading *price P* at any given moment, a *face value F* paid at the very end of the cash flow sequence, at the *maturity* date, and often a periodic *coupon payment C,* expressed as a percentage of the *F.* The *yield* of a fixed-income security is a *d,* such that $P = FV / (1 + d)^n$, and thus the yield and price of a security have an inverse relationship.

Again, given the existence of well-developed financial markets the yields of different securities track one another closely. The financial market in a sense exerts a force on all securities, urging their yields to conform to one another. However, the prices of securities that have long maturities are more sensitive to changes in the prevailing yield and interest rate conditions than those with shorter maturities. The measure of sensitivity is captured in the concept of *duration D,* which is a weighted average of the cash flow times, also called the *average life* of a cash flow.

Fixed-income securities are best understood through the concept of the *term structure* of interest rates. In this structure there is, at any date, a specified interest rate for any maturity date. This is the rate, which would apply on an annual basis to a *zero-coupon* bond of the specified maturity. In other words, the rate is the yield of a security which is priced at *P* today, and entitles to the receipt of the face value *F* at the final date, but no coupon payments. These underlying interest rates are termed *spot rates* and together they define the term structure when plotted as a function of time to maturity. Spot rates are fundamental to the whole interest rate market as they allow calculating an appropriate discount factor and the present value of any fixed future cash flow. Investors generally prefer

liquidity, that is, they prefer short-term maturities relative to long-term maturities and therefore the term structure is typically upward sloping.

Interest rate theory is probably the most widely used financial tool. An example of the applications of interest-rate theory include *hedging* against interest rate risk, i.e. mitigating the risks involved in possible shifts in the term structure of interest rates. An investor may have upcoming obligations, denoted by a negative cash flow sequence, and the possibility to initially acquire a *portfolio*, i.e. a combination, of securities that will be used to pay these obligations as they arise. Even if the *PV* of the cash flow stream resulting from holding the portfolio were equal to that of the obligations, the investor could still be exposed to the risk of not being able to meet his or her obligations as they rise. This is because the holdings in the portfolio and the upcoming obligations may have varying durations and thus the investor would be wise to match both present values, as well as the durations – a process called *immunization*.

2.2.3 Portfolio Theory

Portfolios

Given a collection of assets it is possible to combine individual assets into a *portfolio,* a sort of *master asset*. From the cash flow stream viewpoint, *portfolio theory* is concerned with the analysis of a slightly more difficult class of problems – that of single-period stochastic cash flows. An example is an investment in a physical project that will not provide payment until it is completed. The single-period conceptualization also serves as a good approximation for many securities, especially equities, and the insights from single-period conceptualizations often carry over to many multi-period problems. The basic idea is to characterize an asset using just two measures, the mean and the variance, dismissing ethical or any other arbitrary dimensions.

Portfolio Return

As defined earlier, an asset is an investment opportunity with a resulting cash flow sequence, which can be bought or sold. Analysis usually

assumes that it is also possible to sell an asset, which is not owned, by initially borrowing and selling the asset, and at a later date repurchasing and returning it – a process of *shorting.* If an asset requires investing an initial amount *I,* but also pays back an amount *F* at the end of a single period, the total return *R* of the asset is $R = F / I$, or in percentage terms $r = (F – I) / I$, holding the relation $R = 1 + r$. Given that n different assets are available, each with a random return of x_n at the end of the period, and given that it is possible to acquire a combination of these assets into a master asset with an initial capital of *X,* it is possible to study the mean and variance characteristics of the resulting portfolio at the end of a single period.

Assuming *x* is a random quantity with a finite number of specific values, $x_1, x_2, \ldots, x_m$, and assuming that with each possible x_i there is a probability *pi* that represents the relative chance of an occurrence of x_i. The p_i's then satisfy $\sum p_i = 1$ and $p_i \geq 0$ for each $i = 1, \ldots, m$. The expected value, or "mean" of a random variable x, in the case of a finite possibilities is defined by $E(x) = \sum x_i p_i$. The expected value of a random variable provides a useful quantity of the "center" of a range of possible values; however, typically it is useful to have another quantity measuring the "spread," or degree of deviation around the mean. One such measure is variance, defined for any random variable *y* as *var(y) = E[(y – E(y))^2].* Standard deviation is another frequently used measure and defined as the square root of variance.

When there are several random variables, each with associated possible values and corresponding probabilities, it is possible to summarize the mutual dependence of any two variables by their covariance. If x and y represent two random variables, their covariance is defined as $cov(x_1, x_2) = E[(x – E(x))(y – E(y))]$. When $cov(x_1, x_2) = 0$, the variables are said to be uncorrelated, when $cov(x_1, x_2) > 0$ and when $cov(x_1, x_2) < 0$ the variables are said to be correlated positively and negatively, respectively. Knowing the covariance of two random variables, it is possible to calculate the

variance of the sum of the variables, defined as $var(x + y) = E[(x – E(x) + y – E(y)^2]$.

These concepts can be used to determine the corresponding mean and variance of a portfolio. A portfolio can be defined by allocating fractions w_i of initial wealth to individual assets $i = 1,...n$. The sum of these weights must equal *1*; but some of them may be negative when short-selling is allowed. The weighted return of a portfolio is the weighted sum of its individual assets. The expected return *r* of the portfolio is, likewise, equal to the weighted average of the expected returns *r* of the individual assets: $E(r) = w_1E(r_1) + ...+ w_nE(r_n)$. The variance of the return of the portfolio is defined by a more complicated formula: $var(r) = \sum w_iw_j * cov(r_i, r_j)$, where w_i and w_j are the weights of assets *i* and *j*, and $cov(r_i, r_j)$ the covariance of the return of asset *i* with asset *j*.

Portfolio Diversification

Portfolios with only a few assets may be subject to a high degree of risk, represented by a relatively large variance. By exploiting the covariance of individual assets, it is possible through diversification to reduce portfolio variance. If the returns of individual assets were all uncorrelated, it would be possible to reduce portfolio variance essentially to zero, by increasing n indefinitely. However, in practice, the assets in financial markets are as an aggregate to some extent positively correlated, because they are basically subject to the same macroeconomic conditions, which makes it impossible to diversify away all risk. The risk, which cannot be diversified away in actual markets, is called the *market risk*, or *systematic risk*. *Non-systematic* risk is the difference between the risk of an individual asset and the market risk.

Portfolio Efficiency

From a given collection of n risky assets, there results a set of possible portfolios made from all the possible weights of the n individual assets. When the set thus obtained is plotted in *mean-standard deviation* coordinates, it is called the *feasible region*. Investors who value a portfolio solely on the basis of its mean and standard deviation, and are both risk

averse (i.e. risk is acceptable only with a higher expected return) and insatiable (i.e. more is always better) in their attitude towards wealth, will, by implication focus on those portfolios with a minimum variance for any given expected return, or vice versa, on those with a maximum expected return for any given level of variance. This set of portfolios defines the *Pareto efficient* frontier, that is, the set of portfolios with expected returns that cannot be increased without a simultaneous increase (a trade-off) in variance. Points on the efficient frontier can be characterized and solved by a quadratic optimization problem originally formulated by Markowitz.

Capital Asset Pricing Model

Usually it is appropriate to assume, that there is, in addition to the risky assets, a risk-free asset included in the universe of available investment opportunities. This transforms the Pareto efficient frontier into a straight line, originating from the mean-standard deviation characteristics of the risk-free asset, and extending tangent to the original feasible region into infinity. This leads to the *one-fund theorem*: investors seeking efficient portfolios need only to invest in a combination of the one master fund *F* of risky assets (the point where the Pareto frontier is tangent to the feasible region) and in the risk-free asset. Yet, depending on their degree of risk averseness, investors may prefer different combinations of them.

If everybody uses the mean-variance approach to investing and if everybody has the same estimates of the assets' expected returns, variances and covariances, interesting implications follow. Because everybody invests in the same master fund *F* of risky assets and in the risk-free asset (although in varying proportions) the total sum of all the risky holdings of all the investors must naturally add up to the *market portfolio M* – that is, the total capitalization of the outstanding assets. Therefore the weight of any risky asset in the efficient master fund, which every single investor holds, also corresponds to the proportion of the capitalization of the asset relative the total market capitalization – a certain fractal-like quality of all individual funds being variations of the same master form.

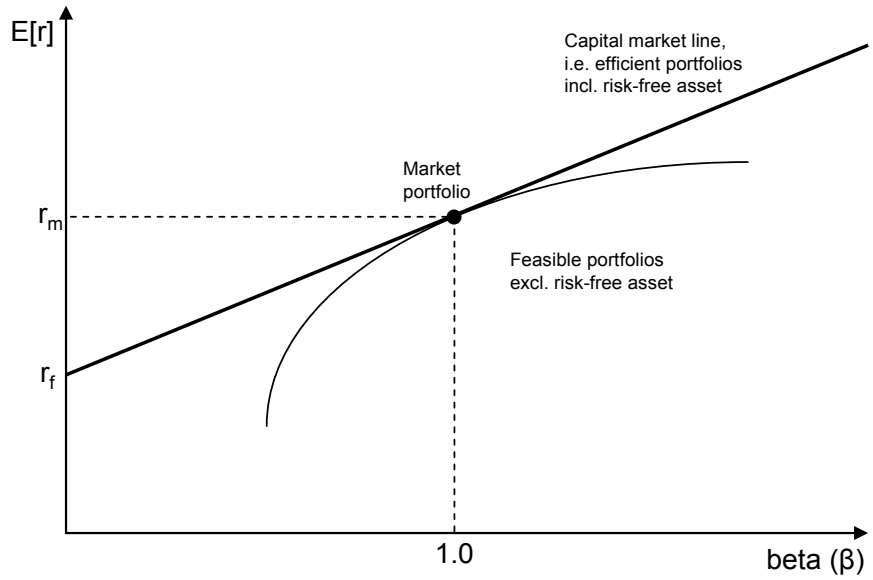

Figure 6 Capital Asset Pricing Model (CAPM)

This approximation of real markets is formalized in the *Capital asset pricing model* (CAPM), in which most of the theory reviewed culminates. The model is derived in a mathematical form from the tangency condition that the master fund, i.e. the market portfolio is on the edge of the feasible region of risky assets. In a mean-standard diagram, a line which emanates from the risk-free asset and touches the feasible region tangent to the market portfolio is called the *capital market line*. Its slope is called the *market price of risk*, and any efficient portfolio must lie on it (Figure 6). Which efficient portfolio an investor prefers, depends on the investor's risk attitude – the domain of utility theory.

The CAPM states that the expected rate of return r_i if any asset i satisfies $E(r_i) = r_f + \beta_i(E(r_M) - r_f)$, where r_f is the risk free interest rate, $E(r_M)$ the expected return on the market portfolio and the value $\beta_i = cov(r_i, r_m) / var(r_m)$ is referred to as the *beta* of an asset – a measure of the covariance of an asset i with the total market portfolio, normalized with the variance of the market portfolio. The value $E(r_i) - r_f$ is termed the *expected excess rate of return*, and the value $\beta_i(E(r_i) - r_f)$ is termed the *risk premium*.

The beta of the market portfolio is by definition equal to *1*, the beta of the risk-free asset is equal to *0*, and for any asset, a greater beta implies a

greater expected return. This changes the concept of risk from the volatility of an individual asset *i* to the covariance of an asset *i* with the total market portfolio, normalized with the variance of the market portfolio. The interest of investors is essentially in the volatility of an asset relative to the market portfolio – beta, i.e. all risky assets provide an uncertain return, but the relevant measure of uncertainty is how sensitive assets are relative to general market conditions.

The CAPM can be applied to pricing individual assets given estimates of the relevant parameters. It can also be used to e.g. evaluate fund performance,[58] or to evaluate single-period projects within firms. Moreover, it is used frequently in association with the weighted average cost of capital model (WACC), to determine the cost of equity for a capital structure that consists of both debt and equity in given proportions. WACC is defined as $r = (1 - t)(r_d)(D) / (D + E) + (r_e)(E) / (D + E)$, where *D* represents *debt capitalization*, *E equity capitalization*, *(D + E) total capitalization, t* the appropriate *tax rate*, r_d the applicable *cost of borrowing*, and r_e the correct *cost of equity* as defined through the CAPM.

[58] e.g. Jensen and Sharpe indices

3 PUBLIC-PRIVATE PARTNERSHIP

In this chapter the notion of Public-Private Partnership is studied by approaching the subject from a number of relevant perspectives. The real-world phenomenon and the associated concept are by no means simple and warrant an in-depth and comprehensive investigation. Because the subject cuts across multiple knowledge domains, it has been addressed from multiple disciplinary backgrounds. Although PPP will ultimately be characterized in terms of fundamental economic concepts in the next chapter, the purpose of this chapter is to gather and summarize insights that other prominent academic backgrounds provide, namely: project business, project finance and public procurement. The chapter is structured into subsections that address each academic discipline in turn.

3.1 PPP as a Form of Project Business

3.1.1 Discipline of Project Business

Public-Private Partnership can be understood as a form of project business and a distinct more of organizing the delivery of major capital investment projects. As stated in the scope of the research, the overarching discipline in this study is project business, although the analysis primarily relies on the concepts of industrial organization and investment theory in its approach. Therefore the purpose of this section is to relate this research to the context of project business literature and study what insights on PPP can be drawn from this discipline.

It is first helpful to distinguish between two disciplines in project business literature: *project management* and *project marketing*. The project management literature defines a project as a temporary organization, to which resources are assigned to undertake a unique, novel and transient endeavor, managing the inherent uncertainty and need for integration in order to deliver beneficial objectives of change.[59] In the project marketing approach, a project is defined as a complex transaction covering a package

[59] Turner & Müller 2003

of products, services and work, specifically designed to create capital assets that produce benefits for a buyer over an extended period of time.[60]

The discipline of project management focuses on the delivery of a single project from the contractor's perspective, emphasizing the concept of a temporary organization.[61] The project marketing approach focuses on project business more broadly as interaction between clients and contractors, emphasizing the concept of a transaction.[62] Project marketing is therefore the broader term; it always implicitly includes project management but not (necessarily) vice versa.[63] The broader focus of the project marketing approach on project business as interaction between clients and contractors, and the implicit inclusion of the project management term make the project marketing discipline more suitable for the study of Public-Private Partnership, which, as the term itself suggests, is essentially a collaborative effort between the public and private sectors.[64]

The characteristics of project-marketing are captured in the rather abstract DUC model, where *D* stands for discontinuous, *U* for unique and *C* for complexity. Projects have a finite life (D), are all different (U) and involve several parties (C).[65] PPPs are also concerned with finite-life legal entities, careful (e.g. financial) engineering is needed to take into account the unique (e.g. cash flow) requirements and constraints of any single project, and a key concern is distributing the expected rewards and risks efficiently, in a manner which creates a genuine community of interest among the various participants.[66]

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[60] Cova, Ghauri & Salle 2002
[61] Cova & Salle 2004
[62] Cova & Salle 2004
[63] Skaates & Tikkanen 2003
[64] Kurkela 2003
[65] Cova & Ghauri 1996
[66] Finnerty 1996

The idea that the PPP scheme is essentially a collaborative effort between the public and private sectors, signifies two important ideas. First, as in all trades, there are two distinct counterparts involved, in this case the public and the private entity, which conform to the two traditional roles of a client and a contractor in project business. Second, the concept of partnership refers to a certain positive mutual interdependence between the demand and supply sides. The parties are assumed to have some degree of shared interests in a PPP scheme, i.e. a non-zero-sum setting, in contrast to a purely competitive zero-sum situation, in which the gains of two parties are strictly opposite.[67] These two principles form the core of PPPs, but the model involves other important features, which are captured in the definition below and elaborated in what follows.

> *"PPP is defined as the procurement of public services and assets by government and local authorities where the private sector is responsible for the design, building, financing and operation of an asset or service for a specified period of time after which it is transferred back into the public sector. The public sector purchases the service from the private sector and pays a fee based on specified output criteria and usage. The private sector consortium uses the fee to repay loans taken out to finance the construction or refurbishment of the asset/service."*[68]

The given definition integrates the procurement and delivery perspectives, and reflects the project marketing approach on project business as interaction between clients and contractors. The definition makes sense, since any project can be conceived of as two parallel projects: an investment project from the perspective of the client (government and local authorities) and a delivery project from the perspective of the contractor (private sector consortium).[69] Moreover, with an assumed

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[67] Such as bargaining the price of a car where increasing the payoffs to one side necessitates an equal decrease in the payoffs to another side. See e.g. Murtoaro, Kujala & Artto 2005

[68] Hallipelto 2005

[69] Artto & Wikström 2005

partnership orientation, it seems inappropriate to view the perspectives in isolation. This project marketing conception serves as the basis for characterizing Public-Private Partnership in the following sections. PPP will be first reviewed from the demand perspective of a public and authority; second, from the supply perspective of private sector; and third, from a joint long-run relationship perspective.

3.1.2 Public Project Procurement Perspective to PPP

First, as a hypothetical case of constructing a highway amply demonstrates, public assets and services are typically broad in both physical and temporal dimension. A stretch of road in the middle of nowhere has little value, but when it is a part of a whole road system, its value increases dramatically. An essential feature of PPPs is that they too represent broader and more integrated procurement objects as opposed to traditional forms procurement, in which the main deliverable is broken down into a number of short-term sub-projects. As a result, activities previously procured through several agreements may now be included under one agreement. A PPP agreement, often called a concession, typically encompasses broad responsibilities in both physical and temporal dimensions, which has major implications for the procurement process.[70]

The implementation of PPPs is organized by granting a concession to a private sector entity, in which the client essentially specifies the service output, payment mechanisms and the term for which the private sector is entitled to operate.[71] This practice necessitates an altogether different procurement procedure, to which traditional practices concerned with tight specifications and bidding lump-sum contracts is inadequate.[72] This has evoked a number of statutory responses as exemplified by e.g. introduction of the negotiated competitive procedure in the EU.[73] Moreover, this causes a shift in the responsibilities and required capabilities of road authorities.

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[70] Tiong 1996
[71] Jokela 2002
[72] Zhang 2004
[73] Kurkela 2003

In contrast to their traditional responsibilities of procuring the design and construction of a project, the authorities are increasingly responsible for compiling the output specification for the road service, reviewing the bidders' proposals, and monitoring contract execution and performance.[74]

Some prior studies in Finland have sought to evaluate the PPP model as an alternative model of procurement to assist construction industry clients, in general, in the strategic selection of the most efficient project delivery methods in relative terms.[75] Results of preliminary empirical research show that the broader and more integrated service packages can provide better value for money and meet the needs and wants of the client better than the traditional ones. However, research also shows that each method should be applied only in appropriate circumstances. It is still often appropriate to use traditional, fragmented models of procurement when projects are relatively small, simple, have well-defined end results, and offer no opportunities to innovate or to generate revenue. The viability of broader, more integrated procurement models increases positively with the size, complexity, ambiguity, innovation and revenue generation opportunities of construction projects.

In the UK, the HM Treasury has commissioned a number of studies on the performance of PPP projects. HM Treasury's 2003 research into 61 PPP projects showed that 89% of projects were delivered on time or early; 70% of PPP projects were delivered on time with no cost overruns borne by the public sector; and 77% of public sector managers reported that the overall performance of the private sector partner was matching up to expectations at the time of contract close. These findings are in stark contrast to the study of UK National Audit Office, which found that only 30% of traditionally procured construction projects were delivered on time and only 27% were within budget. An increasing body of evidence has shown

[74] Lahdenperä & Rintala 2003
[75] Koppinen & Lahdenperä 2004a, 2004b

that the better risk management of PPPs results in a greater proportion of assets being delivered on time and to budget.[76]

3.1.3 Private Project Delivery Perspective to PPP

Second, the participation in a PPP significantly expands the responsibilities of the private sector. For this reason several private sector parties typically join forces in multiple separate consortia in order to compete for a concession, concerned with e.g. major infrastructure and related services. No single party typically has the capabilities to deliver the project or to take on the risks involved alone. Organizing a consortium around a special project company diversifies the risk and allows the collaboration of specialized parties.[77]

The basic idea in distinguishing between different project delivery alternatives is the allocation of responsibilities from the client to the contractor regarding a given project. It is possible to include an arbitrary number of classifying variables, since a project involves an arbitrary number of responsibilities depending on the level of resolution. Approaches differ from e.g. Pietroforte and Miller,[78] who distinguish between two variables (finance and scope of delivery), to Kiiras,[79] whose approach involves picking a unique solution from a "tray" of options resulting in a very large number of possible combinations. Another approach commonly used involves denoting certain key responsibilities with acronyms, such as *D*-Design, *B*-Build, *O*-Operate (or –Own), *F*-Finance, *L*-Lease, *T*-Transfer (or –Train), and referring to the project type by the responsibilities allocated to the contractor, for example *DB* - Design and Build contract.

These acronyms are also used as a reference to main phases of a project in time, conventionally in the sequence *D-F-B-O-T*. A prevalent construction

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[76] HM Treasury 2004
[77] Bing, Akintoye, Edwards & Hardcastle 2004
[78] Pietroforte & Miller 2002
[79] Kiiras 2004

industry trend is the combination of previously separate responsibilities into larger wholes, in terms of scope and temporal dimension.[80] This has spurred the development of several new construction management techniques. For example, the extension of the construction industry responsibilities from short-term execution to longer-term operation has contributed to the development of a number of new project management techniques, such as life-cycle planning and costing.

The Finnish construction industry, in consonance with international trends, has recently adopted new models of delivering construction services. These non-traditional models have been reportedly developed to better respond to some of the industry's challenges, more specifically, conditions characterized by high uncertainty in the process and/or high ambiguity about the final product.[81] The delivery of projects with one or both of these attributes can benefit significantly from interaction on part of designers, implementers and clients. For example, to manage risks, identify efficient design solutions and to shorten the total time of delivery by making the project phases partly parallel.

Examples of the new delivery models are: project implementation management; integrated design and implementation; and integrated design, implementation and maintenance (life-cycle contracting, i.e. PPP). The model of integrated design and implementation has received a good reception around the world, especially in the US, the UK and the Netherlands. In Japan over half of construction projects are based on this model of operation. Project implementation management, in turn, has been used in major industrial and power plant projects for some time already, but it is only recently that it has been utilized in public procurement and construction of commercial facilities. Finally, life-cycle contracting has been successfully implemented in joint public and private construction projects elsewhere in Europe, and more recently in Finland as well.

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[80] Koppinen & Lahdenperä 2004a
[81] Rakennusteollisuus 2002

Nevertheless, the key idea from the private sector perspective is that PPPs are concerned with meaningful wholes, capable of being financed and functioning as an economically viable and technologically separable legal entity. This conception is arguably much more powerful, as well as practically useful, in understanding PPP than any amount of detail captured in combinations of detailed acronyms or project "trays." The approach of using variations such as *BOO*, *BLT*, *BOOM*, is a legacy of construction management thinking and does not serve very well in capturing the holistic and cross-disciplinary nature of PPPs. From the perspective of construction management a PPP project is simply one composition of responsibilities and there is nothing special with adding a finance component to the tray. However, this is a rather narrow, even flawed assumption, as this study later argues.

3.1.4 Joint Private-Public Perspective to PPP

Third, the collaborative feature of PPPs deserves elaboration. A predominant feature of the construction industry has been the difficulty associated with integrating the interests of various organizational groups, mainly clients, contractors and consultants.[82] Industry wide failures to achieve substantial increases in productivity in construction, and the need to control escalating construction dispute levels have raised arguments against the adversarial scenarios perpetuated in most traditional procurement paths. These often position the constructor against the architects/engineers/client, rather than encouraging teamwork toward common targets.

In essence, a project collects together a temporary network of economically independent actors, whose interests converge in the objective of producing the final deliverable, but diverge in distributing the economic benefits gained thereby. This partly collaborative and partly competitive nature of project business, caused essentially by organizational

[82] Berggren, Soderlund & Anderson 2001

fragmentation,[83] has recently attracted considerable attention among researchers.

Within project industry, increasing awareness of these shortcomings has led to wide experimentation and a proliferation of procurement options, but even such initiatives have failed to achieve significant breakthroughs, and the search for appropriate procurement-delivery systems thus continues. Cox and Townsend attributed such shortcomings to a failure to deal with the ‘‘structure’’ of the construction industry and the consequential arrangements, which they saw as the root cause of its major problems.[84] The same basic problem has been addressed by other scholars in an attempt to describe and potentially reconcile the tension through e.g. the concept of hybrid organizations and the framework of networks.[85]

3.1.5 Summary of Project Business Insights on PPP

The figure below (Figure 7) summarizes the lessons on PPP, based on the literature of project business. The logic of the representation is again to show the line of thinking for each major insight, starting with the basic conditions of traditional project business practices (left side) and show an intermediate, development step describing the evolution in project business, leading to the conditions, which characterize PPP (right side).

[83] Berggren, Soderlund & Anderson 2001
[84] Cox and Townsend 1997
[85] See e.g. Jarillo 1988 and Williamson 1991

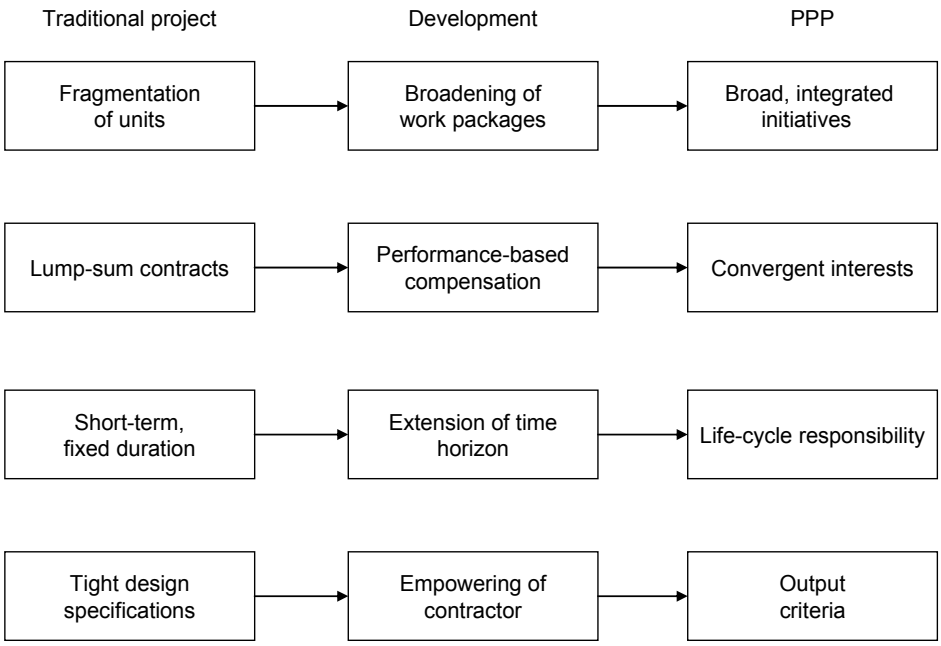

Figure 7 Differences of PPP relative to traditional project business practices

The top of the figure signifies the integration of traditionally fragmented works and services of design, building, financing and operation into more sizeable, broader project delivery. The second flow of development represents the development from lump-sum compensation schemes to performance based fees, which helps align the interests of traditionally adversial parties to a project. The third level signifies the extension of the construction industry supplier responsibilities from short-term execution to longer-term operation, and the consequent life-cycle responsibility thereby gained. The bottom row refers to a higher liberty given to the project supplier to design the project, based on specified output criteria instead of tight, client defined specifications.

In summary, it seems PPP arrangements, while neither possible nor advisable on all projects, provide a means to address the over-fragmentation of functions that has previously led to divergent - if not confrontational agendas of the multiple participants. While superficially an extension of the design-build mode, i.e. enhanced by the addition of two functions of finance and operation, PPP in reality differs in terms of

philosophy and potential benefits, spelling out a significant mind shift and a change in the procurement-delivery paradigm.[86]

3.2 PPP as an Application Area of Project Finance

3.2.1 Discipline of Project Finance

The historical and disciplinary origins of PPP can be traced to another abbreviation known as PFI – the Private Finance Initiative. Interest in PPPs remained modest until the beginning of the 1990s, when a dramatic expansion of interest in PPPs was triggered by the launch of the PFI scheme under the Thatcher government in the UK in 1992. PFI viewed private finance as a formative part of a new public procurement model designed to meet the nation's enormous infrastructure needs. The inclusion of private finance in the provision of public infrastructure assets and services falls under the discipline known as project finance.[87] The purpose of this section is to relate this study to the context of project finance and study what insights on PPP can be drawn from this discipline in turn.

To understand the concept and discipline of project finance it is necessary to first distinguish between direct-finance and project-based finance. Financing a project on a general credit basis is known as direct financing. In direct financing, a firm or a government is financed by taking into account information on all related assets, its current status, and future prospects, usually gauged in a single standard measure, such as a credit rating.

Project financing represents an alternative to conventional direct financing, and can be defined as "raising funds to finance an economically separable capital investment project by issuing securities or incurring bank borrowings that are designed to be serviced and redeemed out of project cash flows." [88] Therefore choosing project financing over direct financing also involves choosing an alternative organizational form, a project

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[86] Kumaraswamy & Morris 2002
[87] Finnerty 1996
[88] Finnerty 1996

company that is different from the traditional corporation, which is a key distinction and has certain fundamental implications explored later.

3.2.2 Application of Project Finance in PPP Schemes

The main application area of project financing is in large, capital-intensive projects. A great variety of investments have been project financed, including pipelines, refineries, electric power generating facilities, dock facilities, mineral processing facilities and highways. The PPP market in the UK is beginning to mature, with approximately 600 PFI facilities in operation, and over 450 deals with a value of more than €50 billion signed between 1999 and 2004. In spite of this activity, PFIs represent only a moderate share, approximately 6% of a total of €72 billion of annual public sector investment in public services. [89]

On a global scale, since 1994 the private sector has invested funds totaling circa €220 billion into PPPs across the world, but mainly in the commonwealth countries UK, Australia and Canada. From January 1994 to September 2005, PPP deals with a value of approximately €100 billion closed across Europe. Of these deals, two thirds closed in the UK, and approximately one tenth in each Spain and Portugal. In 2004 and 2005, around 206 PPP deals worth approximately €42 billion were closed in the world, of which 152 projects with a value of €21 billion were in Europe. Evidence of strong deal flow in the pipeline suggests PPP activity is set increase across Europe in the future.[90]

The key project participants in a PPP project finance scheme include the granting authority, usually a government agency; the project supplier – typically called the project sponsor; and usually one or more financial institutions. The granting authority identifies project requirements, establishes the concession period, solicits tenders, and awards the contract. A private sponsor finances, designs, and builds the project and then operates it for a specified concession period. The project sponsor typically

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[89] See e.g. HM Treasury 2003
[90] Dealogic ProjectWare 2005

is a consortium or a joint venture of engineering, construction, and venture capital firms. During this concession period, the sponsor collects revenues from operating the project to recover its investment and earn a profit. At the end of the concession period, ownership of the project is transferred to the granting authority. The financial institutions may involve corporate banks, insurance companies, or investment banks.

Three of the major challenges facing a prospective sponsor are estimation of project costs, projection of revenues during the concession period, and financial engineering. Considering the enormous capital that major infrastructure assets typically require,[91] and the participation of the private-sector in funding the projects, it is not surprising that financing is one of the key issues in organizing PPPs.[92] The financial package usually has a greater impact on a PPP project's viability than the physical design or construction costs.[93]

PPP projects are usually funded with both equity and debt. The capital structure in most PPP projects is highly leveraged. Equity financing typically covers only 10–30% of total project costs, while debt financing is obtained for the remaining 70–90%. Equity investors may be those who are solely interested in a return on their investments, such as public shareholders and institutional investors, or those who have direct interest in project operation, such as general contractors, designers, and operation and maintenance firms.[94] Granting authorities and lenders inevitably are concerned about the equity level in evaluating the risk and viability of the project.[95] A significant level of equity investment is a competitive advantage when tendering a PPP project, because it demonstrates a high level of commitment by the project sponsors.[96]

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[91] Tiong 1995
[92] Chang & Chen 2001
[93] Zhang 2005
[94] Tiong 1995
[95] Schaufelberger & Wipadapisut 2003
[96] Tiong 1995

Non-recourse debt instruments are used for debt financing of PPP projects to ensure that lenders have no recourse against the participants in the sponsoring consortium; instead, they must rely on the revenue generated by the project as the source for loan repayment. The objectives that PPP project sponsors try to achieve in structuring the debt financing are maximization of long-term debt, maximization of fixed-rate financing, and minimization of refinancing risk.[97]

Besides funds, the other side of the coin in financing is security. Lenders will not typically extend funds to a project if their loans are exposed to commercial or economic risk. Lenders are typically willing to bear some financial risk, but they will insist on compensated for bearing such risk. Security arrangements are designed to fortify the credit strength of a project. In effect, they increase the proportion of a project's construction costs that can be funded with project borrowings.

Since PPP projects involve two very different phases, a high-risk construction and a relatively low-risk operation period, security arrangements fall into two general categories: First, those that ensure project construction phase completion (or else repayment of project debt in full); and second, those that ensure timely payment during the operation of the facility. In some cases, long-term non-recourse debt financing cannot be obtained until construction is completed. Project sponsors may use equity to finance the construction and refinance with debt financing or public sale of stock once the major construction is completed.

3.2.3 Insights on PPP from the Research on Project Finance

The basic idea in this section is to review the academic research on project finance, and to explicate the conditions which are necessary and sufficient for an infrastructure to be financed on a project-basis, as well as the advantages and disadvantages, which follow from this choice. It seems helpful to first state the conclusion, so as to provide a foundation to which

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[97] Tiong & Alum 1997

the following review can be related. In brief, the *necessary* condition for an infrastructure project to be a viable PPP candidate is that it must be capable of operating as a stand-alone economic unit; the *sufficient* condition for an infrastructure project to be organized through a PPP scheme is that it must provide comparative advantages to alternative courses of procurement.

The problem from a theoretical perspective is therefore concerned with selecting between two alternative courses of action, financing on a direct or on a project basis, each resulting in a certain cash flow pattern, which need to be examined with an objective criterion such as the NPV. A comprehensive evaluation would therefore require quantification of all involved costs and benefits and discounting them into a single present value using appropriate discount factors for each course of action. This is a highly complicated exercise and practically impossible, and therefore research has been restricted to examining the advantages and disadvantages related to each alternative in a more qualitative sense. In the following paragraphs the disadvantages, advantages and their potential joint effect is explored in light of prior research.

There are two main disadvantages related to financing on a project basis. The first is that project finance involves complications in the search of potential sources of funds, detailed financial planning, and extensive negotiations, leading to increased transaction costs as compared with the more simple procedure of borrowing on a general credit. Dudkin, in cooperation with the European Investment Bank (EIB), has sought to provide a tentative quantification of the relative transaction costs.[98] In short, the results indicate that transaction costs of PPPs are substantially higher than those involved in traditional paths.

The second important disadvantage is the fact that the project has no operating history and only indirect credit support, which together lead to an increase in risk and higher cost of capital. For any lender, and for any

[98] Dudkin 2005

given degree of leverage in the capital structure, the cost of debt is typically higher than in comparable direct finance. Because of the lack of operation, there is no evidence of actual performance – only financial projections, which are less credible, causing increased (perceived) risk. Moreover, the indirect nature of credit support increases the risk of default, because contractual commitments provide the basis for debt service instead of direct responsibility to pay.[99] However, since it is impossible to evade the fact that projects are unique by nature, it can be argued that a fair cost of capital should reflect this property.

Scholars have also sought to explain the advantages of project financing, which may partially offset the disadvantages of evidently higher transaction costs and cost of borrowing. In some instances project financing may even provide a comparative advantage over direct financing. The advantages are intimately tied to the property of an economically separable capital investment project. In the following paragraphs, five tentative explanations are reviewed.

First, project financing may permit a higher *degree of leverage* than the sponsors could achieve on their own, leading to additional *tax shield benefits*, which may together result in a lower overall cost of capital, given that cost of equity is higher than the cost of borrowing and tax shield effects considered in union.[100]

Second, project finance can reduce the costs of the *agency cost of free cash flow*, by giving investors the right to control reinvestment of the project's free cash flow.[101] In short, managers, when left to their own devices, i.e. without direct exposure to the discipline of capital markets, may not be sufficiently demanding when evaluating projects, and thus reinvest free cash flow into inefficient uses. Forcing the cash flow to be dispersed, gives investors control of the uses to which the free cash flow will be put.

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[99] Finnerty 1996
[100] Finnerty 1996
[101] Jensen 1986

Third, project financing can mitigate the *underinvestment problem* that arises when firms have risky debt outstanding.[102] A firm with a highly leveraged capital structure may prefer to forgo a capital investment project, which has a positive NPV, but a negative impact on shareholders, since management is essentially concerned with the interests of owners. The reason being that taking on more debt to realize a project may decrease equity share price, when the markets interpret the project prospects as less desirable than the risks arising from an even higher leverage. Financing the project separately would allow the project to be evaluated and financed on its own merits, thus creating economic value that would otherwise not be realized.

Fourth, project financing may facilitate the *design of debt contracts at a lower-cost*, because the contracts can be linked directly to the cash flow characteristics of the project assets. The inherent conflicts of interest between shareholders and lenders give rise to a variety of agency costs, and lenders deal with these agency costs by negotiating covenant structures that are contained in loan agreements, and typically costly to implement.[103] In a specific project, it is generally easier and therefore less costly to design a debt contract which gives lenders a senior claim on the cash flow of the firm, net of operating expenses.

Fifth, project financing can *enhance the effectiveness with which assets are managed*. Brickley, Lease and Smith have explored the link between ownership structure of the firm and firm value.[104] They note that when managers have a direct share in the profits of a project, they can be strongly motivated to make decisions that enhance its profitability, thus aligning more closely the objectives of the firm's professional managers and its other investors. Moreover, Chemmanur and John have noted that management's relative abilities differ across business, and it may be

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[102] John & John 1991
[103] Jensen & Meckling 1976
[104] Brickley, Lease & Smith 1988

advantageous to establish a separate project and hire management with comparatively superior abilities.[105]

3.2.4 Net Effect of the Advantages and Disadvantages of Project Finance in PPP

The figure below (Figure 8) summarizes the lessons on PPP provided by research on project finance. The logic of the representation is to show the advantages of project finance (left side) and the disadvantages of project finance (right side), and their net effect that determines whether or not project finance should be used in any particular instance (middle).

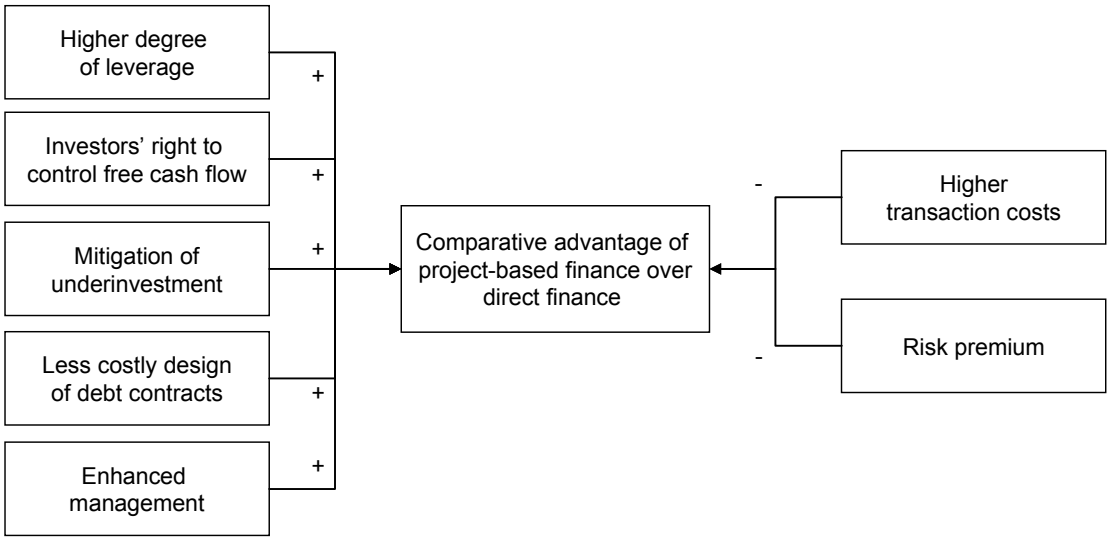

Figure 8 Net effect of advantages and disadvantages of project finance

In light of prior theoretical study on project finance, when both financing alternatives are available, project financing is more cost-effective than conventional direct financing when: First, the benefits of a higher degree of leverage; second, the investors' right to control reinvestment of the project's free cash flow; third, the appropriate selection of investment opportunities; fourth, the design of less costly debt contracts; and fifth, an enhanced management *offset* the higher transaction costs and the risk premium that is required.

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[105] Chemmanur & John 1992

3.3 PPP in the Context of Public Procurement Legislation

3.3.1 Public Procurement Legislation and Protocol

PPP is also typically associated with the term *public procurement*, which is, in fact, somewhat misleading since a PPP concession is noticeably different from ordinary public procurement procedures and contracts. Nevertheless, literature on public procurement highlights the importance of a proper allocation of risk, when a public authority considers *contracting out*, *delegating responsibility*, or *distributing risk* related to an infrastructure project. This theme is also intimately tied with the distribution of rewards, since more risk and responsibility is customarily acceptable only with a higher expected return. The purpose of this section is to relate this study to the context of public procurement and study what insights on PPP can be drawn from perspective.

A public authority cannot arbitrarily choose how it contracts, delegates responsibility and distributes risks; it is subject to juridical constraints, captured in procurement law.[106] Regardless of the country involved or the type of contract used, public procurement law involves responses to three interdependent domains of consideration (Figure 9).

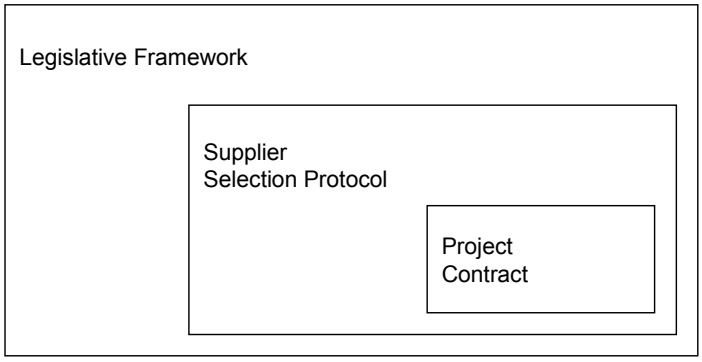

Figure 9 Illustration of the interdependence of legislative framework, supplier selection protocol and project contract in public procurement

First, an appropriate legal framework must be set up to accommodate any given type of contract or selection protocol. Second, a public entity will be required to follow a specified contract award process within the legal

[106] Kurkela 2003

framework. Third, a contract must be introduced to bind both parties as an outcome of the selection protocol, within the legislative framework. The first two juridical considerations will be elaborated in turn in the following paragraphs, and project contracts will be reviewed in more detail in the following section.

Generally speaking, the current statutory norms defining the procurement law were developed for the application of traditional, segmented, works and services procurement and direct funding of infrastructure projects, and based on the underlying idea that complete specifications are available. The Anglo-Saxon legal tradition calls for anticipating every potential scenario ahead of time,[107] so that adaptations, such as variation orders are treated as anomalies, and little consideration is given to outline discussion conditions – so-called landscaping amenity clauses in jurisprudence.

Over the years, the current procurement law has created both a ubiquitous and complex administrative system that is geared to undisciplined allocation of scarce public resources, a fierce competition among public agencies to access insufficient funds, and raising dispute levels, all contributing to inefficiencies. The continuous reliance on segmented delivery has fostered a facility planning culture of initial delivery only, away from a long-term approach in which a portfolio of facilities and their related life-cycle costs are considered. In the context of PPP, the use of integrated, long-term delivery methods (in conjunction with segmented, short-term delivery methods, where appropriate) can have a significantly positive impact on infrastructure portfolio performance.[108] The planning and structuring requirements of these methods impose a holistic consideration of an infrastructure production process.

From an economic perspective, the basic challenge in designing a proper supplier selection protocol is to overcome the problems arising from asymmetric information, by ensuring that the selection mechanism gives

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[107] Perrot & Chatelus 1994
[108] Pietroforte & Miller 2002

those who possess hidden information the incentive to reveal it.[109] In principle, the government and the suppliers could rely on bargaining to converge on a contract. However, we have already noted that under an *information asymmetry,'* bargaining may not be efficient, which basically stems from the fact that both parties would like to appropriate the gains from the trade, but run the risk of foregoing the trade by being too demanding. To ensure efficiency, i.e. that the party who is in the best position to undertake a project, the government typically relies on auction mechanisms, or more specifically, *reverse auctions* – settings with one buyer and multiple potential sellers.

The reason why a client uses a reverse auction mechanism instead of individual contract negotiations is simple: the competitive element between potential suppliers may lead the client to capture a greater share of the surplus that the trade implies.[110] In a pure negotiation situation, a supplier is concerned with claiming a maximum share of the payoffs generated by joint action; in auctions, the supplier is also concerned with accessing any payoffs in the first place.

Typically, contractors seek to maximize their expected payoff, that is, the product of contract payoff and the probability of winning. In minimum bid auctions, a low bid is associated with lower payoffs, i.e. a bad contract, but a higher probability of winning. A high bid implies high payoffs, but risks loosing the contract. A contractor is induced to submit a bid, which enables the client to capture a great proportion of the total gains implied by the project.

In other words, the government, by including more than one supplier in the game, transforms individual negotiations into a reverse auction, thereby gaining higher bargaining power, and securing more of the surplus yields implied by the project. The figure (Figure 10) below illustrates the rationale schematically.

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[109] Jehle & Reny 2000

[110] Raiffa, Richardson & Metcalfe 2002

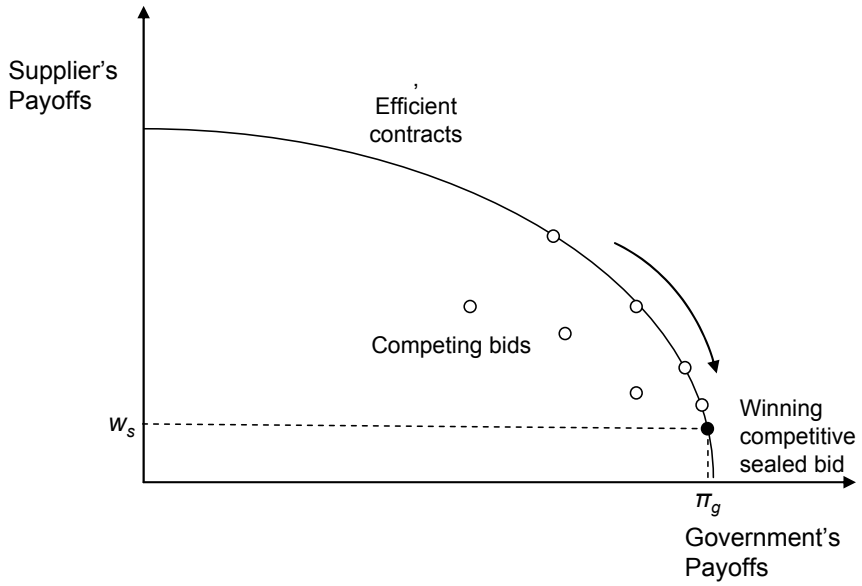

Figure 10 The competitive dynamics of a competitive sealed bid procedure

The frontier denoted as efficient contracts represents the "size of the cake" to be divided, i.e. the maximum surplus yields that a project implies. The arrow signifies the competitive tension between supplier candidates, who are "pushed" to submit a low bid that leaves them with only a "small share of the cake", i.e. minor payoffs relative to not trading at all. The government exploits this tension to receive the project at a lowest possible cost, which leaves the government with a "major share of the cake," i.e. large net payoffs.

There are multiple different mechanisms that the client can employ, for example the competitive sealed bid, the Dutch auction, the Vickrey auction, or the reciprocal bid.[111] By far the most used is the competitive sealed bid, where each of several bidders submits a sealed-bid value for a given project, and the bid with the minimum value will win the project. For a typical example, a government awards the contract for building a certain facility, such as a stretch of a highway. Various contracting firms seek the project, each submits a competitive sealed bid with a fixed price, and the bid with the lowest cost to the government wins the contract.

[111] Raiffa et al. 2002

These economic ideas are reflected in current public procurement provisions. According to Kurkela,[112] the underlying objectives of procurement provisions are to increase competition, transparency, ensure fair treatment of bidders, and promote cost efficiency. Under current law, project contracts must be awarded through competitive sealed bids (open or restricted), the procurement unit must make bid evaluation criteria explicit, describe mutual relationship of separate contracts through bridge-clauses, and employ standard boiler-plate clauses. The rationale is that the government minimizes project costs to the benefit of general welfare by acquiring a good or service through an auction, where competition guarantees the authority will receive it at the lowest possible price. Even though more advanced auction mechanisms involve multiple criteria, price is still the decisive factor for winning a project.

The figure below (Figure 11) illustrates the flow of the traditional procurement protocol in selecting a supplier. The process begins with designing exhaustive specifications of the project, which are subsequently announced. Supplier candidates independently formulate tenders on basis of the specifications, submit bids, and the government awards the project to the supplier, which offers to match the specifications at the minimum cost. This procedure can be used when the government has a precise idea on the technical options and specifications to be chosen. Suppliers can be asked to submit bids in strict accordance with the specifications imposed by the government and final selection is made on a price basis alone and little room for negotiation is left to the selected candidate.

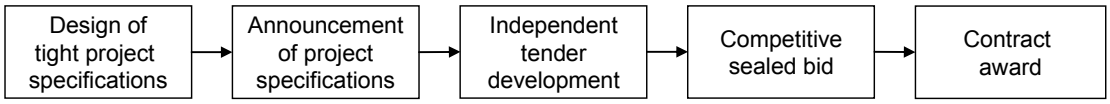

Figure 11 Illustration of the general flow of the competitive sealed bid procedure

Nonetheless, the use of a bidding mechanism to procure a good or a service requires a near-exhaustive specification of the object of exchange.

[112] Kurkela 2003

The procurement of infrastructure assets and services through competitive sealed bidding is problematic, when projects are very large in physical scale, long in temporal duration, and when all future contingencies are impossible or too costly to specify.

Under these conditions it seems to be advantageous not to seek precision from the outset, so as to save on contracting costs and provide flexibility over the life of the project.[113] In particular when uncertainties remain on technical options to be retained, it may be undesirable or impractical to prepare complete technical specifications in advance. The past decade of industry experience tends to advance this position and suggests starting out general tender specifications and with incomplete contracts, which promote dynamic adjustment in the contract over time. If all contract parameters cannot be fully anticipated, if actors are developing some of new knowledge during the action process itself, the use of negotiation and arbitration procedures, designed as a learning process is to be favoured. [114]

Where the completeness of contracts decreases, the role of negotiation and arbitration mechanisms increases. Therefore, under complexity and uncertainty, a concessionaire selection protocol could benefit from increased reliance on negotiations as well as the involvement of an independent, specialized arbitration body from the outset. The *competitive-negotiated procedure* detailed below (Figure 12) has been developed by various public organizations to respond to such conditions, and so as to fit in with European Union legal requirements.

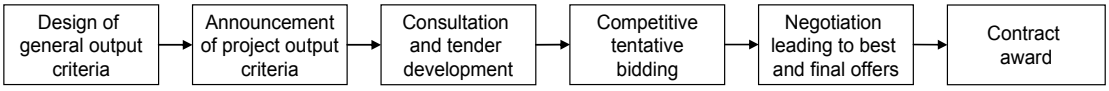

Figure 12 Illustration of the general flow of the competitive negotiated procedure

The process begins with a government designing general conceptual or performance specifications, followed by the announcement of the project,

[113] Pietroforte & Miller 2002
[114] Pietroforte & Miller 2002

where interested bidders are requested to register. The government typically selects 5-6 qualified bidders to continue. In the next stage, bidders are allowed to consult the government for information as they formulate their tenders for the bidding stage. All pre-qualified bidders are first invited to submit an un-priced, technical bid based on a conceptual design, after which typically two candidates are selected to continue with negotiations. In the negotiations stage technical and commercial clarifications and adjustments are made, culminating in the submission of final technical proposals and priced bids (Best and Final Offers - BAFOs), from which the government selects the better one and awards the contract accordingly.

3.3.2 Public Procurement Contracts

Traditional public procurement typically consists of a budget-funded, short-term, segmented procurement procedure without consideration to private capital investment, a long-term contract period, or integrated responsibilities. To put PPP concession contracts in context, we will next study the various contracting alternatives to the production of infrastructure goods from a government-supplier relationship perspective. The figure (Figure 13) below summarizes the main types of alternatives available to public procurement and each of the alternatives, up to PPP concessions, will be elaborated briefly in what follows.

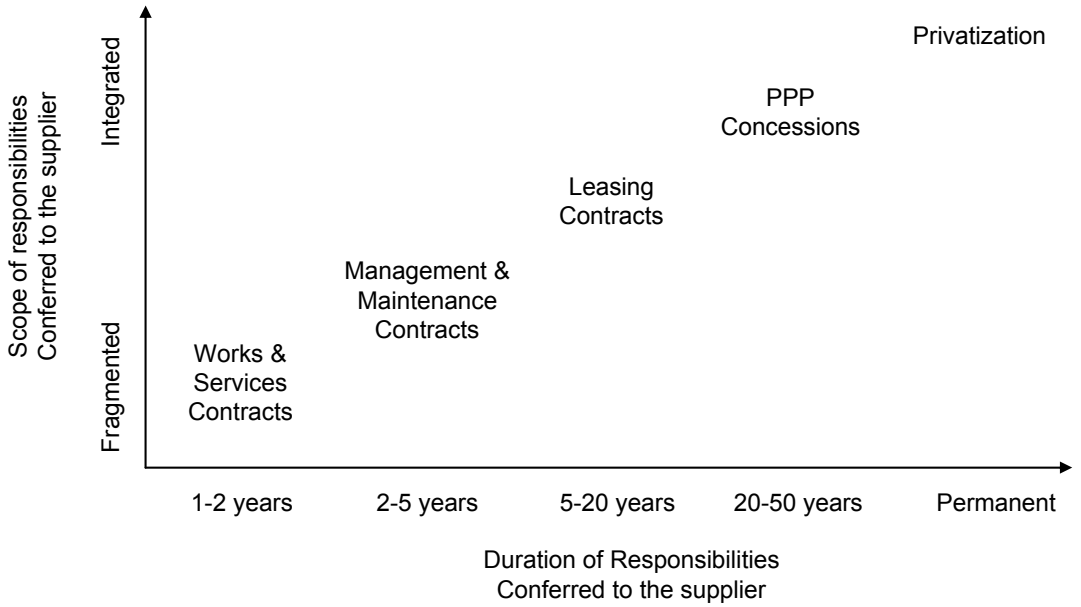

Figure 13 Classification of public procurement contracts based on the scope and duration of responsibilities conferred to the supplier

The logic of the figure is to show on the horizontal axis the temporal scope, i.e. duration of responsibilities conferred to the supplier, and on the vertical axis the physical scope, i.e. the breadth of responsibilities with respect to both vertical and horizontal dimension. Broadly speaking, the risks and expected rewards of the supplier increase positively with physical and temporal responsibilities, in the direction of the upper-right hand diagonal.

3.3.3 Works and Services Contracts

Traditionally, government road agencies procure single works or services from the private sector for infrastructure purposes. DBB (Design-Bid-Build) is a delivery system in which the client procures design and construction services separately. DB (Design–Build) is a delivery system in which the client procures design and construction services from a single entity. Design-Build is probably the oldest project delivery method in the Western world, since the origins of construction are characterized by the

lack of distinction between design and construction responsibilities. For example, the meaning of the Greek word architektòn is chief builder.[115]

A turnkey contract is almost identical to DB, but its contract looks more like a sale than a contract for services. Turnkey may include financing, and payment by the client is typically made at the completion. It is a standard practice to award DB and turnkey contracts on the basis of preliminary design. A partial project (PP) is an arrangement in which specific parts of a meaningful, separate project are contracted out to different contractors (general contractors or subcontractors). Contractually these contractors are directly bound to the client, who acts as a general contractor or construction manager.

3.3.4 Management and Maintenance Contracts

Management and maintenance contracts are arrangements, where a private company is entrusted with various types of tasks usually performed by the public authority, relating to the organization of road maintenance operations. Usually, the function of the private firm is to respond to day-to-day routine maintenance requirements by contracting private companies, on behalf of the public entity, to perform the works. Management contracts can also (or only) focus on operation management. In this case, typical tasks entrusted to the private sector are: traffic counting, axle-load weighing and providing traffic information, traffic management including surveillance, stand-by services for accidents, traffic regulation, toll collection (usually not remunerated on the basis of the amounts collected but rather on a fixed rate basis).

3.3.5 Leasing Contract

In a leasing contract, the lessee manages either the facilities side or the operations side of the project and is remunerated primarily through service fees paid by users. A leasing contract is in fact equivalent to the

[115] Pietroforte & Miller 2002

management contract, with the addition of “success fee,” which is the disposing value of the asset or service.

3.3.6 PPP Concession

In a PPP concession, government designates a right to the supplier to undertake a project and entitles the supplier to remuneration. The concessionaire carries out all of the capital investment, operates the resulting service and is compensated primarily through service fees paid by the government (shadow-tolls) or users (tolls). The facilities are to be handed over to the oversight public authority at the end of the contract period.

Several variations of PPP exist. In a BOOT (Build-Own-Operate-Transfer) model, several private entities via a series of contracts finance, build, own and operate an infrastructure facility designed to accommodate the set of needs established by the public authority, which in many instances acts as guarantor for the project. Ownership of the facility is to be transferred to the public authority upon expiration of the contract. BOT (Build-Operate-Transfer) is another variant of the PPP contract, whereby facility ownership is transferred to the public authority once the building phase has been completed. In a BOO (Build-Own-Operate) model the facility ownership remains in the hands of the private investors beyond the contract’s expiration. Finally, in a reverse BOOT model, the public authority finances and builds the facility, and then confers service operations to a private firm which assumes ownership as the building phase winds down.[116]

There is also a growing body of jurisprudence that considers the requisite features of a PPP concession. This literature entails typically intuitively appealing notions, but reveals little about the economic rationales that underlie them, or how they are achieved in practice. Nevertheless, for background understanding and a reference, we can briefly characterize the

[116] Pietroforte & Miller 2002

features that juridical literature suggests a PPP concession contract should reflect.[117]

First, the partnership nature of the government-concessionaire relationship requires that the *loyalty principle* is a defining feature of the contract, both as an *informal attitude* as well as a formal *juridical obligation*. As in all contracts, the parties are expected to "*use best efforts*" to *honor commitments.*[118] However, a concession also presupposes that the parties to the trade should replace confrontational settings and instead exert *continuous efforts*, in an *orderly manner*, to serve the *joint economic interests* and divide resulting joint gains in a *fair manner* among the public agency and the operator company. The concession should acknowledge that the *contract clauses are based on assumptions* of future conditions, and where *realized events* deviate from *expected ones*, the parties should *react to evolving circumstances* so that *contract balance is sustained*. The parties are also encouraged to employ *bonuses* and *sanctions* so that unilateral, self-interested action is discouraged.

3.3.7 Summary of PPP in the Context of Public Procurement

A public authority cannot arbitrarily choose how it contracts, delegates responsibility and distributes risks; it is subject to juridical constraints, captured in procurement law. Regardless of the country involved or the type of contract used, public procurement law involves responses to three interdependent domains of consideration. First, an appropriate legal framework must be set up to accommodate any given type of contract or selection protocol. Second, a public entity will be required to follow a specified contract award process within the legal framework. Third, a contract must be introduced to bind both parties as an outcome of the selection protocol, within the legislative framework. Based on the review of the context of public procurement we may summarize the changes associated with using PPP instead of traditional contracting practices.

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[117] See e.g. Kurkela 2003

[118] "Pacta sunt servanda" in jurisprudence

The table (Table 2) below summarizes the key insights. Starting with the top row, the contracts used in the traditional path of procurement conform to works and services contracts, whereas as a PPP is awarded through a concession – a temporary right to operate an asset. However, there are certain key variations of each contract, presented on the second row. The scope of responsibilities conferred to any particular supplier in the traditional approach is fragmented and the contract duration is typically 1-2 years, whereas in PPP, the scope of responsibilities is integrated and the duration is typically 20-50 years. The supplier selection protocol employed in the traditional approach is a reverse auction mechanism, namely the competitive sealed bid, whereas a PPP concession is awarded through a competitive- negotiated procedure.

Table 2 Description of the main dimensions of development in public procurement

Dimension	Traditional Public Procurement	PPP
Contract type	Works and services	Concession
Main contract variations	DBB, DB (Turnkey), PP	BOOT, BOT, BOO, Reverse BOOT
Scope of responsibilities	Fragmented	Integrated
Duration of responsibilities	1-2 years	20-50 years
Supplier selection protocol	Competitive sealed bid; in strict accordance with pre-formulated specifications	Competitive-negotiated procedure; iterative tendering against general output criteria

4 ECONOMICS OF TRANSPORT INFRASTRUCTURE PRODUCTION

In this chapter the underlying economics of transport infrastructure production and PPP are studied. It is important to inquire into why should both public and private sector involvement be desired and what roles they play, respectively. The basic idea is that this chapter clarifies what a PPP essentially is, and how it differs from the traditional path of public infrastructure procurement, which is a tension that will later be leveraged to study the comparative efficiency of PPP reduced to some fundamental concepts of economic theory. The chapter is divided into four sections, of which the first characterizes the economic nature of transport infrastructure goods; the second describes the organization of their production through a PPP scheme; the third through the path of traditional public procurement; and the final one summarizes the key features of each approach.

4.1 Economic Characteristics of Transport Infrastructure Goods

The purpose of this section is to deepen and clarify the understanding of PPP by constructing an economic model of PPP and contrasting it with traditional public infrastructure procurement, based on the conceptual frameworks of industrial organization and financial theory. The ways in which PPP differs from the traditional path of public infrastructure procurement helps to understand the defining features of the scheme in the context of transport infrastructure production, but is also a tension that will later be leveraged to study the relative efficiency of PPP reduced to the fundamentals of economic theory (Figure 14).

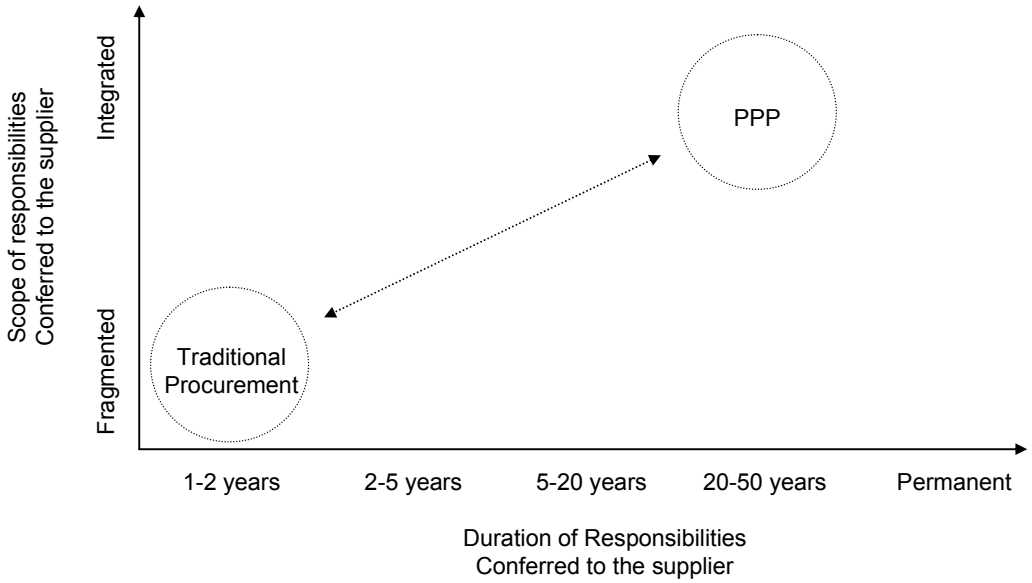

Figure 14 Description of the polar alternatives to the production of infrastructure goods

Given the relatively recent introduction of PPP schemes, there is not as yet a substantial body of academic literature on such projects and most descriptions are informal. It thus seems justified to rely on basic theory to develop a robust economic conception of PPP. There are four essential characteristics that infrastructure goods exhibit, elaborated in what follows.

First, it is important to note that transport infrastructure is not a pure public good that exhibits no exclusion or rivalry; instead transport infrastructure is common property to which everyone has free access, but the benefits exhibit rivalry: by occupying a space on the highway excludes others from occupying the same space. The infrastructure is also a capital good, because the externalities are created over a long-run period, and the benefits are primarily valued as an input to the production processes of firms or individual citizen-consumers.[119]

[119] Although some enthusiasts may enjoy driving on a highway for the thrill in its own sake.

Moreover, it seems essential to highlight that infrastructure is best understood as an experience good. The product characteristics such as quality or total price (cost) are difficult to observe in advance before purchase, but these characteristics become evident upon consumption of the good over its total lifecycle. This experiential quality seems to capture a fundamental problem of the construction business, where the client cannot, in advance easily *observe* or *verify*, sometimes let alone *specify* the characteristics of the unique product in question. Client preferences may change over time, and the actual characteristics typically become evident only after a substantial time, sometimes only after the standard warranty period is over. In economic terminology, transport infrastructure thus involves the production of a *common capital experience good*. The reasoning behind this conclusion is illustrated in the figure (Figure 15) below.

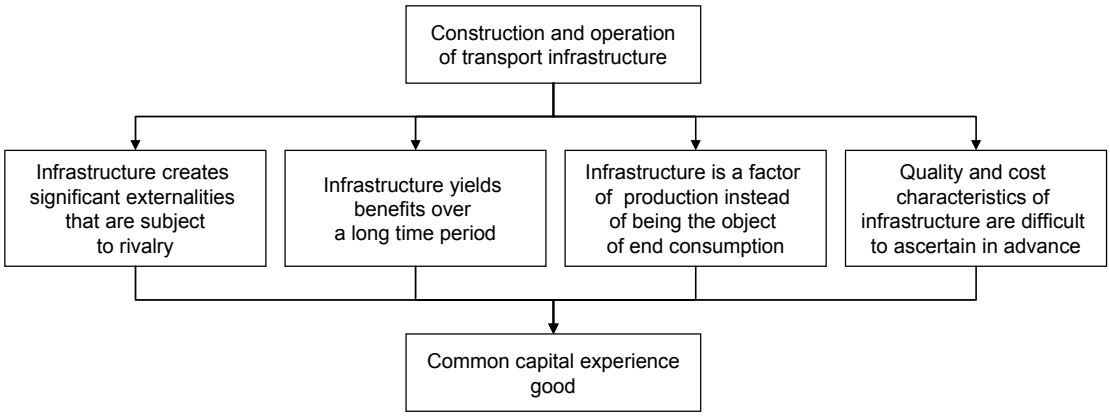

Figure 15 The economic characteristics of transport infrastructure goods

In summary, transport infrastructure assets and services create significant positive externalities that are difficult for a supplier to internalize, which is why the market fails to provide the good, and which is also the reason it is desirable for a government to intervene and ensure its production, given that the total, social revenues (private revenue plus the value of externalities) are higher than the total, social costs (private costs plus the costs of externalities.

The road users internalize the positive externalities, and the government prices the externalities by raising various taxes, e.g. vehicle and gasoline,

taxes from road users. The government forwards some portion of the tax revenues to the supplier, so that the supplier internalizes some of the positive externalities it generates. The revenues of the supplier are termed as private revenue, and the supplier's production costs are termed private costs. Even if the supplier were allowed to set tolls for the highway, i.e. generate private revenue, such as is the case in PPP, the government still typically subsidizes production, because tolls alone do not allow the producer internalizing all the benefits from road externalities, i.e. social revenue.

4.2 Economic Model of PPP in Transport Infrastructure Production

4.2.1 Production in PPP

There are multiple representations of PPP in literature; however, they are typically directed at a non-academic audience and lack a rigorous theoretical foundation. The models of PPP typically describe the key parties and their contractual relationships,[120] or key phases of a PPP project,[121] and so forth. Moreover, they do not seem to capture some of the basic requirements for an economic model of PPP. First, because a PPP is concerned with an inter-temporal, typically even 30-year project, the model must account for multiple time periods. Second, it is reasonable to assume that an infrastructure project is inherently risky, and therefore the model must account for uncertainty. Third, to maintain economic and financial orientation, the terms of the model must represent quantitative, monetary values.

A motivation in this section is therefore to develop a deeper understanding of PPP by constructing a model that addresses these requirements. The development of the model necessitates making certain approximations, which should, however, not compromise the validity of the study, but simply clarify thinking. The objective is to develop a model, which is a

[120] Kankainen, Linholm, et al. 2001
[121] Kurkela 2003

broad enough approximation to be valid, but narrow enough to focus the study on only the critical aspects of PPP.

To begin the development along these lines, let us first assume a hypothetical highway infrastructure project, in which the government is the sole buyer and the project is awarded through a project contract to a sole supplier (who may nevertheless use subcontractors to deliver the project). The project involves designing and constructing a highway and maintaining it for a time span of T years. The infrastructure will be in operation for T minus construction period P, after which it is simply disposed at zero value. Next, let us assume that the construction period P is one year, $P = 1$, and the engineering and construction of the infrastructure assets requires an investment of I. The investment I is used in full to compensate consultants for designing, and construction contractors for completing the highway infrastructure.

When completed, having the infrastructure asset and the complementary services required to operate it effectively delivers total annual positive externalities of B. Let us assume for simplicity, that these benefits are constant[122] and represent the total sum of all the annual value that citizen-consumers gain from using the highway for their personal purposes, all the logistics benefits that firms and non-profit organizations gain, and all imaginable multiplicative effects of stimulating the economy in general, i.e. the social benefit minus private revenue.

However, having the highway in operation also incurs a constant, annual private cost of $C < B$,[123] which means that the highway is costly, but socially desirable. Suppose that the private cost C includes all the maintenance, repair, street lighting, management and any other imaginable operating cost related to the infrastructure. Let us assume for the present that the negative externalities of the infrastructure asset, such as air and

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[122] This assumption can easily be relaxed, and the annual benefits can be treated as variable for calculation purposes

[123] Again, this assumption can easily be relaxed, and the annual benefits can be treated as variable for calculation purposes

noise pollution are irrelevant, for instance, because they are small enough to be negligible, or they are expected to be borne by the government. Moreover, the government prices the positive externalities by estimating the total social benefits, and charges the society appropriately in the form of taxes *t*, e.g. vehicle and gasoline taxes.

Let us assume that the operating infrastructure asset can be represented with sufficient accuracy in terms of four dimensions: the units of passage along the route *q*, average availability of lanes *l*, the safety of the route *s*, and quality of maintenance *m*, so that we can characterize the asset as $A = f(q, l, s, m)$ during any period after *P*. Let us assume that a good approximation of the social externalities that the asset generates, *B,* is a function of *A,* so that $B = f(A)$ during any period after *P*. This seems to be a reasonable assumption, since as more units pass along the route; more lanes are available and so forth, the higher the value of the externalities to the society.

The supplier of the infrastructure asset assumes responsibility of constructing the infrastructure and operating it until *T*, but the supplier will generate no revenue until the asset is in operation. When in operation, the supplier will receive private revenue *R* from the buyer, the government, specified by a typical payment mechanism, which is also a function of *A*, $R = \mathbf{r}(A)$, where $\mathbf{r}$ is a vector that represents the private revenue coefficients of the payment mechanism, corresponding to the units of passage along the route *q*, average availability of lanes *l*, the safety of the route *s*, and quality of maintenance *m*.

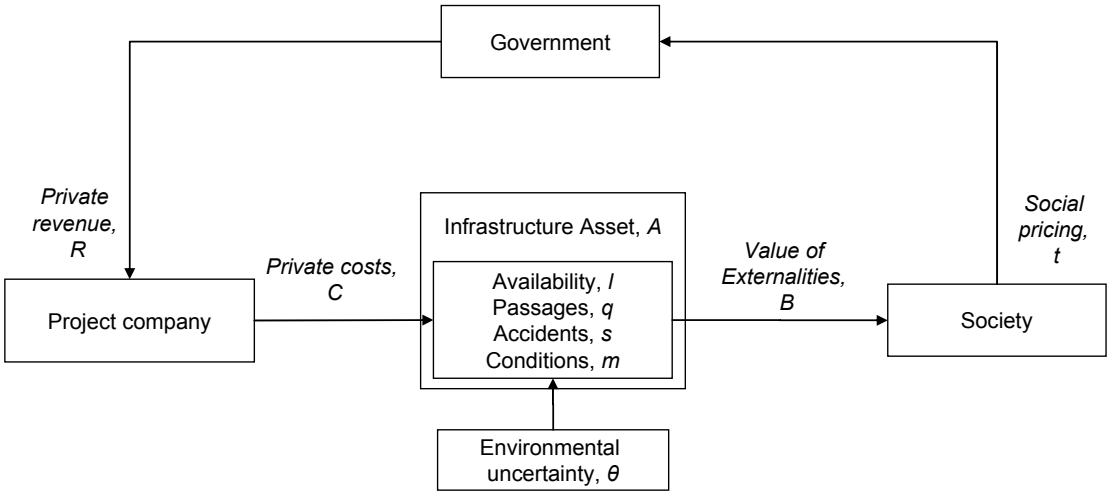

Figure 16 Distinction between infrastructure asset, value of externalities, social pricing, private revenue, private costs and environmental uncertainty

Let us also approximate the annual cost of C as a function of B, $C = \boldsymbol{c}(A)$, where $\boldsymbol{c}$ is a vector that represents the private cost coefficients corresponding to the units of passage along the route q, average availability of lanes l, the safety of the route s, and quality of maintenance m. This seems to be a reasonable assumption as well, since as more units pass along the route, more lanes are available and so forth, the higher the effort that is required in terms of maintenance, repair, and so forth is. Let us further denote the private net revenues N of the supplier by $N = R - C$.

Next, suppose that the project is also inherently risky. This is a very reasonable assumption for most economic activities. In the case of constructing and operating a highway for a long term, risks arise from material and labor cost, engineering calculations, technological solutions, geological uncertainties, weather conditions, plain human error, traffic forecasts and many other possible sources of disturbance to the project execution. The realization of these risks could cause extra costs, schedule delays, and lower-than-expected performance of the completed infrastructure.

It is imperative to understand, that the aggregate, underlying risks of a venture are the same, regardless of how the risks are distributed among participants. The uncertainty related to a capital investment project is

independent of the client or the firm that undertakes the project. The value of the project is based on its ability to generate cash flows. If a particular firm can generate higher expected future cash flows, i.e. higher benefits, lower costs, or both, using the project's assets, the project will add more value to that firm than to other firms. Differences in the value of a project among firms are reflected in the expected cash flows (not in the cost of capital), because the *project risks depend on the project's design.*[124]

Let us denote all the underlying uncertain events related to a project by one term, θ. These uncertain events or *pure risks* therefore pertain to the expected *C,* to the expected *B,* and indirectly through *B* to *R.* In principle, we could model each of these three terms as random variables; however, capturing all the uncertainty in one term, θ, aligns the approach with the basic logic of financial markets. Within the framework of financial markets, investors share a simple way to reflect the uncertainty regarding future cost and revenue calculations: the cost of capital. For any capital investment project, i.e. asset, investors capture future uncertainty by applying an appropriate discounting rate, using the principles of interest rate theory and CAPM. Therefore, we can anticipate that the expected rate of return *r* financiers would expect from this particular project is closely related to θ, i.e. $r \sim \theta$.

Suppose that the supplier of the asset and related services is a separate private company, with no operating history or assets (except for a minimum equity contribution of *E*). The infrastructure requires an equal initial investment of *I* at period *P.* The private party would need to evaluate the project on its own merits and access the financial markets to raise funds for the project as a separate economic unit. Potential debt investors would assess whether or not *C* and *R* projections are realistic, and assuming so, they would be willing to lend an amount *D* of funds at an interest rate r_d, which is a fair rate, given all actual risks inherent and other investment opportunities available. Let us assume that $E << I$, sot that we

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[124] Flemming & Mayer 1997, Finnerty 1996; this idea will be explored in more detail in the next chapter

can for the present reasonably omit the effect of E and the rate of return r_e on E in the analysis, and assume that the supplier would finance the project entirely on debt D.

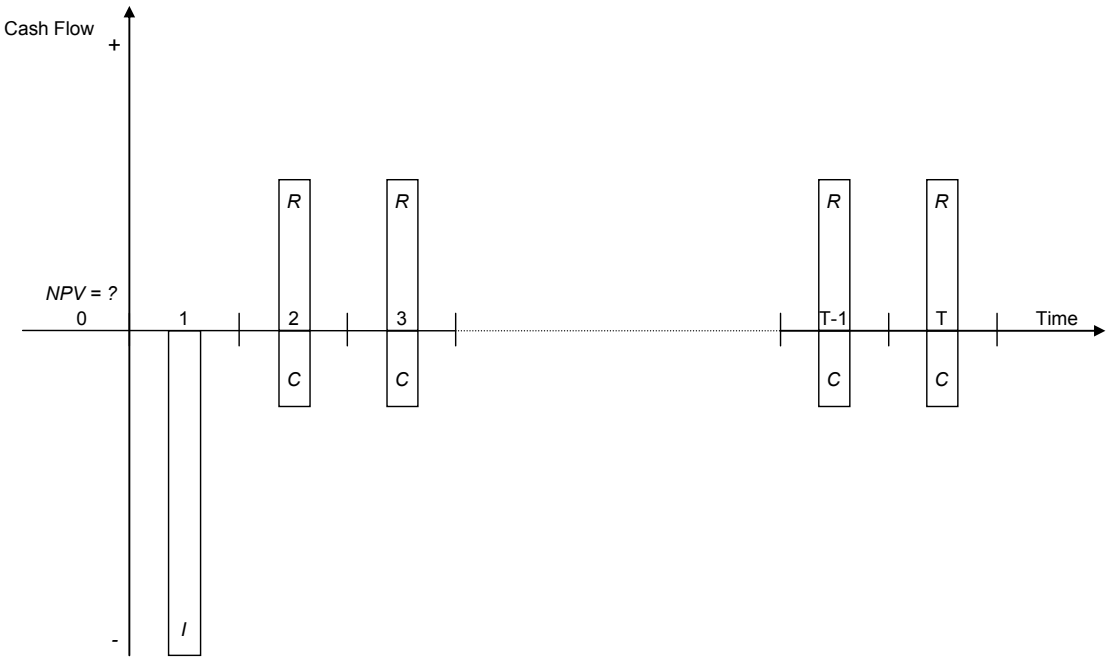

Figure 17 Illustration of the investment, private revenues and private costs in PPP

Assuming that debt investors are prudent investment analysts, the interest rate r_d is then also the appropriate discounting rate that captures the risks in the project. From a producer perspective, the project is worth realizing, if the project has a positive net present value initially, i.e. at period *0*. The net present value of the project, as a function of the cost of capital r_d, for the supplier is defined by $NPV(r_d) = \sum(N_i / r_d \text{ ^}i) - I$, where $i = 1, 2, \ldots, T$, and $N = 0$, for $i = 1$, and $N = R - C$, for all $i = 2, 3, \ldots, T$. The figure above (Figure 17) gives a schematic representation of the supplier's cash flows.

The figure below (Figure 18) schematically summarizes the main participants and key terms in the model of PPP. The logic of the representation is to show the key parties, the key periodic cash flows, and the uncertainty of the project, reflected in the debt and equity cost of capital. The box in the middle represents the supplier, which in the case of PPP is a separate project company, for all practical purposes equivalent to

the underlying asset it manages. The engineering and construction of the infrastructure asset ties up capital equal to *I*, the cost of construction, which is raised from in the form of debt *D* from financial institutions in debt markets and the form of equity *E* from equity investors (for the present, we assume that $E << I$, so that *E* and $r_{e.}$ are negligible).

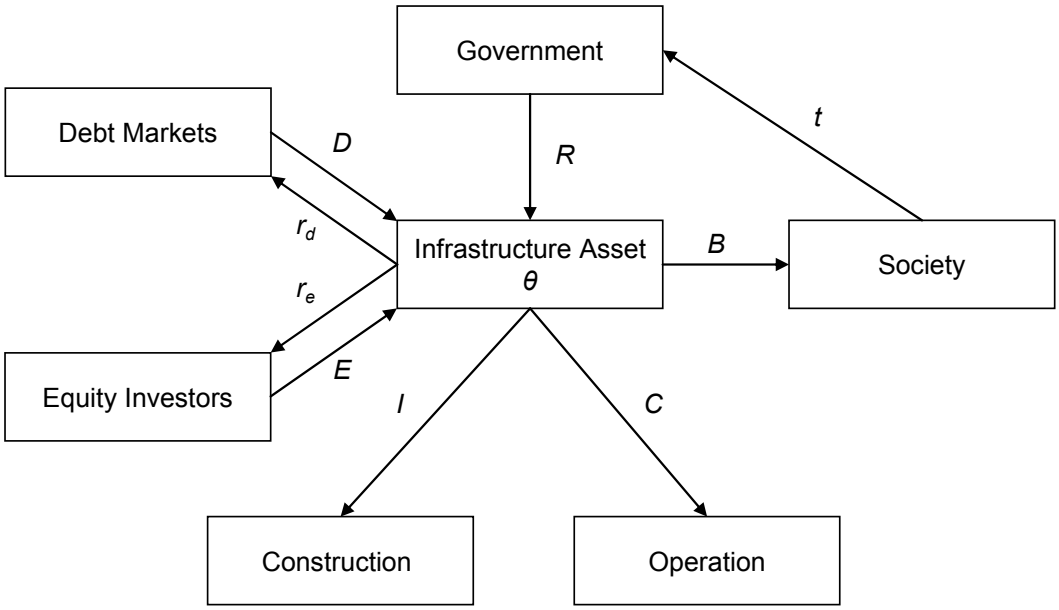

Figure 18 A descriptive model of the key parties and flows of funds in Public-Private Partnership

Having the asset in operation delivers annual aggregate benefits of *B* to the society, but incurs a constant annual cost of *C* to the project company, which goes to sub-contractors. The government raises various taxes *t*, e.g. vehicle and gasoline, which it channels through its budget to pay for the supplier's efforts as defined by $R = \boldsymbol{r}(B)$. The supplier uses this revenue to cover its operating costs defined by $C = \boldsymbol{c}(B)$, and to service its capital liabilities. The uncertainty θ related to future *R* (or equivalently *B*) and *C* projections are captured in an interest rate $r_{d,}$ which is the rate at which financiers are willing to commit capital for the project and therefore appropriate for evaluating the net present value of the project. A PPP project is then defined analytically by the simple formula $NPV(r_d) = \sum(N_i / r_d \text{ ^}i) - I.$

Similar representations of PPP are abundant in literature, but generally speaking they do not provide a unified treatment of the key parties, the key flows of money, a dynamic time conception and uncertainty. The model constructed here addresses all these features and suffices to tie to a single, common basis the themes that have emerged in the literature on PPP, namely value for money (VfM) considerations, relative efficiency of the public and private sector and cost of capital concerns.

The first two common themes, namely *relative efficiency* and *value for money considerations* relate to the terms *B* and *C* in the model. Relative efficiency between the traditional paths of procurement and PPP simply refers to differences in *C,* holding *B* constant. Similarly, value for money considerations between the traditional paths of procurement and PPP refer to the differences in the ratio of *B* versus *C*. Effects of PPP on *B* and *C* will be elaborated after a review of the third theme. The third theme, the *cost of capital* concern refers to differences in discount rate r_d, holding in turn both *B* and *C* constant, and will be addressed by an analysis based on investment theory in the next chapter.

4.2.2 Contractual Relationship in a PPP Concession

A most notable difference in the contractual relationship between the traditional procurement contract and a PPP concession are positive incentives, captured in the payment mechanism. Another important feature is the incompleteness of the contract, with the consequential allocation of (temporary) asset ownership to the concessionaire as well as neutral arbitration mechanisms that are typically set in place from the outset and designed to mitigate the moral hazards involved with incomplete contracts.

As explained earlier, incentives are the only way to induce optimal effort and ensure the efficiency of a contract, when effort is not easily specifiable, observable or verifiable. The PPP concession therefore makes heavy use of incentives to induce high effort and thereby avoid agency costs. However, PPP schemes involve significant complexity and uncertainty as well, which is why a cost-minimizing contractual relationship involves the creation and allocation of limited authority to the

concessionaire as well as the enactment of neutral arbitration mechanisms to handle contingent circumstances at the lowest possible cost.

However, let us for the present focus on the incentives in the contractual relationship, and next subject the payment mechanism in a PPP concession contract to an analysis based on the principal-agent framework. The analysis requires the development of a model of the government-concessionaire relationship, which subsequently allows developing insight into the compensation scheme between the government and the private supplier. The purpose is, again, to develop an analytical model, which is a sufficient approximation of the principal-agent relationship between the government and the concessionaire and allows us to draw some conclusions within the limits of the model.

First, let us assume that we can again characterize the infrastructure asset A with sufficient accuracy using the variables availability l, passages q, accidents s, and road conditions m, so that $A = f(l, q, s, m)$. Second, suppose we can approximate the relationship in terms of the concessionaire revenue R defined by the payment mechanism, the private costs C of operating the asset, and the total social benefits resulting from externalities B. As earlier, suppose all of these variables are directly dependent on A, so that $R = f(A)$, $C = f(A)$, and $B = f(A)$.[125] Third, suppose that R is, in fact, a fraction r of B, which simply means that the government remunerates the project company by leaking a share of the total value of social externalities to it.

Let us also assume that the performance of the infrastructure asset depends on the efforts of the project company management, and that we can distinguish between two different types of effort, cost-saving e_c and benefit-enhancing efforts e_b. Finally, let us include a random variable θ,

[125] This is very reasonable, because the variables q, l, s, m that approximate social externalities are also the basis of the payment mechanism and presumably higher externalities require higher costly production

which captures all the pure risks related to the performance of the asset *A,* and which therefore pertain into *R, C* and *B*.

Total social profit π_s that the asset generates is then defined by $\pi_s = B(e_b) - C(e_c) - \theta$. The private profit π_p is dependent on the performance of the infrastructure, its costs and a random term, so that $\pi_p = (r)B(e_b) - C(e_c) - \theta$. The government is a representative of the society and its "profit" π_g resulting from the externalities net of payment to the project company is defined by $\pi_g = (1 - r)B(e_b)$. This setting allows us to draw some simple conclusions (Figure 19).

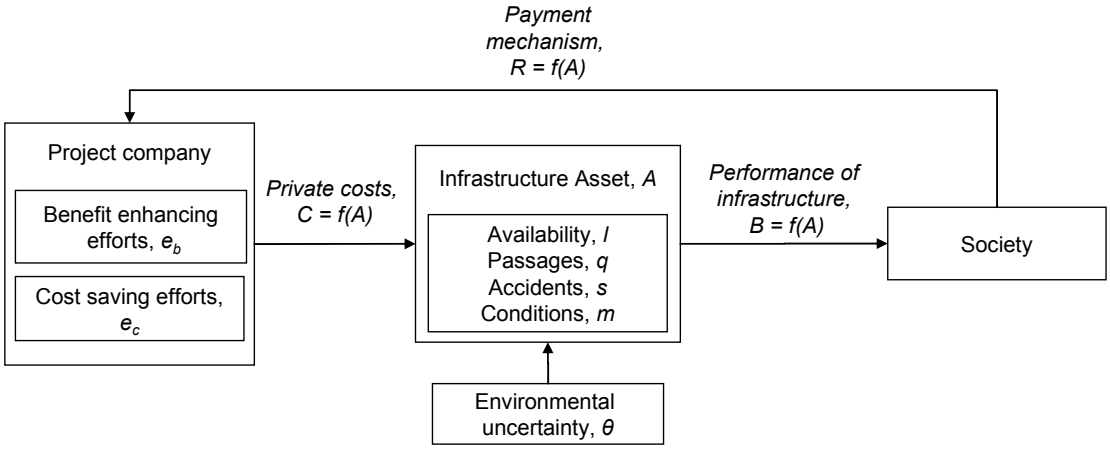

Figure 19 Principal-Agent model of the PPP concession

First, the compensation structure of the concession makes the contract efficient, because it aligns the interests of the project company, whose profits are $\pi_p = (r)B(e_b) - C(e_c) - \theta$, and the government $\pi_g = (1 - r)B(e_b)$. The concessionaire has every incentive to contribute to the performance of the asset, because this increases its revenues, but this also improves the value of the service to the government. The contract thus represents a profit-sharing mechanism, which is incentive-compatible. Therefore, PPP seems to involve lower agency costs, because the project is acknowledged to be costly to monitor and effort is primarily induced through *incentives*.

However, within the limits of this setting, it is easy to see that the private company has a much higher incentive to exert effort on cost savings *C* than

increasing the benefits *B*. This is so because it captures only a fraction *r* of the effort it gives to improving the service, but all the *yields* from cost saving efforts e_c go to the project company – the government "profit" is independent of the costs, $\pi_g = (1 - r)B(e_b)$. The concession therefore ensures efficiency, but unless the revenue mechanism is tied to the costs as well, it favors the project company in the long-run, and equitability of the contract is not ensured.

Within the limits of this model we can also infer that the private company assumes all *production risks* related to general macroeconomic conditions and input and prices unique to the particular infrastructure asset. Or more accurately, the financiers of the private company assume the risk θ, which is reasonable, given that they are also entitled to all the surplus yields from cost savings.

4.3 Comparable Economic Model of Traditional Public Procurement

4.3.1 Production in Traditional Public Procurement

The traditional procurement practice typically involves separation of e.g. design, engineering, construction, and operation functions, as well sub-division of responsibilities within these functions, and is therefore customarily characterized as fragmented. The fragmented nature of the traditional procurement path stands in stark contrast to the broader and more integrated service package that characterizes PPPs, which means that comparing the traditional approach to the PPP scheme seems a good way to develop insight into the defining features and differences between the two. For this purpose, we will next develop a model that approximates the traditional path of infrastructure procurement.

There is a diversity of contracts and associated organizational arrangements in project procurement, with some very recent and innovative schemes as well. However, the traditional, lump-sum, short-term works and services contract remains by far the most used contemporary contracting model in the procurement of public infrastructure assets. Because there is basically an infinite variety even of

this contractual model, it is necessary to employ a stylized model, which (hopefully) captures the essential features of the traditional alternative.

To develop a good comparable reference to PPP, we will again assume the same hypothetical highway infrastructure project as in the development of the PPP model. However, in the traditional approach no separate project company is established; the government finances the infrastructure investment by borrowing on its general credit rating; and contracts with construction companies and operators through fragmented, short-term, lump-sum competitive bidding, when it does not rely on its own producer units. The long-run management and integration of multiple works contracts remains with the public sector; works are exhaustively specified, and the public sector carries out design prior to procurement. Finally, private contractors are responsible for the deliverables only within standard warranty periods. The figure below (Figure 20) schematically summarizes the main participants and key terms in the traditional model of infrastructure production.

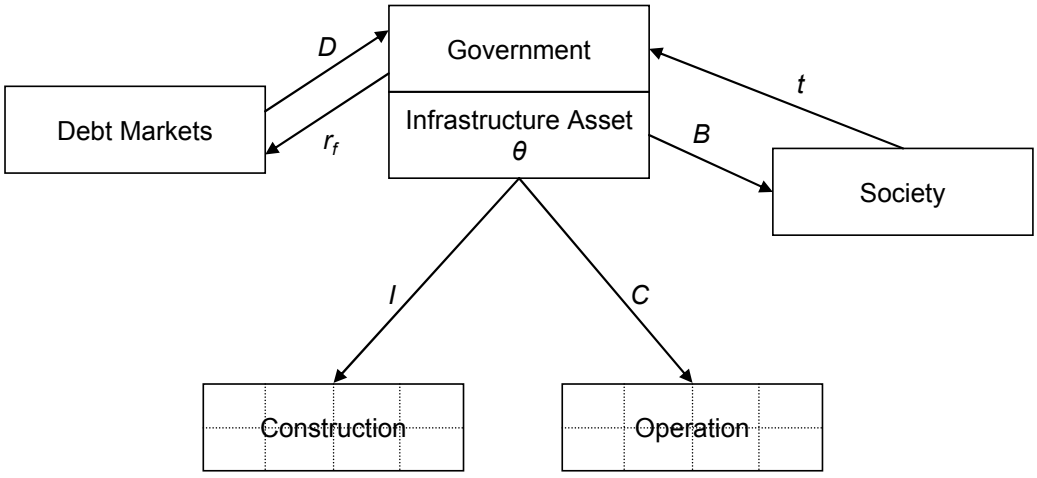

Figure 20 A model of the key parties and flows of funds in traditional procurement

The most important issues to notice are that the infrastructure asset is represented as inseparable from the government, who finances and holds ownership to the asset, and that both construction and operation are fragmented. The long-term risks θ related to the asset are internalized and hidden in the government entity. The construction of the infrastructure

asset again ties up capital equal to *I*, the cost of construction, which is raised from in the form of debt *D* from financial institutions in debt markets at the risk-free rate of interest.

Furthermore, having the asset in operation delivers annual aggregate benefits of *B* to the society, but incurs a constant annual private cost of *C* to the government, which goes to sub-contractors. The government raises various taxes *t*, e.g. vehicle and gasoline taxes, which it channels through its budget to cover its operating costs defined by *C,* and to service its debt capital liabilities. The boxes representing construction and operation are split into sections to emphasize the idea, that the traditional procurement is typically concerned with more narrow works and services packages in both physical and temporal scope. The procurement and production of an infrastructure asset equivalent to a PPP project is thus achieved by a composite of multiple smaller projects in both physical and temporal scope.

4.3.2 Contractual Relationship in Traditional Public Procurement

Let us next briefly explore the consequences of the contractual relationship in traditional procurement practices more formally by applying the principal-agent framework. Let us denote the total social revenue of an infrastructure project by π, the contractor's efforts by *e,* the contractor's compensation by *w,* and include a random variable θ, which captures the risks of the project. It is important to note that the risks imply the potential for an upside as well as a downside. For example, the material or labor costs may turn out to be lower or higher than initially expected.

Suppose next that the government enacts a typical competitive tendering process, through which it awards the project to the contractor that offers to deliver the project at the lowest constant wage *w.* In the principal-agent terminology, a lump-sum contract is a variant of the a *fixed fee contract*, where the wage *w* to the contractor is independent of π, *or e,* and the contractor takes on the risks θ, so that the government receives $\pi_g = f(e) - w$. The cost-plus contract is equivalent to a *hire contract*, where the contractor receives remuneration based on some observable output

measure e and a unit wage w, so that the government receives $\pi_g = f(e) - we$.

Let us further assume that the total profit is positively dependent on some level of effort e that is costly to the contractor, who can also choose between two levels of effort, high e^* and low e. Suppose that e^* represents effort that conforms to the specifications of the government, and e represents deviation from the specifications. Suppose also that e^* costs more than e to the contractor by a factor of $c > 1$, so that $e^* = ce$.[126] Moreover, the government typically employs *hostages*, i.e. negative incentives, which take the form of a direct monetary post m, which the contractor loses in addition to the contract if its efforts deviate from what is agreed.

Let us assume the project is ultimately completed by the contractor. The contractors profit π_p, when it conforms to the contract specifications in a fixed fee contract is therefore $\pi_p = w - ce + \theta$, and when it *shirks*, and does not to deliver what is specified, *but is not caught*, its profit is defined by $\pi_p = w - e + \theta$; *if caught,* it loses the hostage m, and its profit is defined by $\pi_p = w - e + \theta - m$. Similarly, in a hire contract, the contractor's profit π_p, when it conforms to the specifications is therefore $\pi_p = we - ce + \theta$, and when it fails to provide what it is paid to provide, its profit is defined by $\pi_p = w - e + \theta$ or $\pi_p = w - e + \theta - m$, depending whether the government catches the contractor shirking.

The important idea to realize is that, in essence, both contract types require that the contractor's effort e is *specifiable*, *observable* and *verifiable* by the government. Under these conditions, the government can choose the desirable level of effort e^* and impose it on the contractor, with the threat of the large punishment m if the contractor shirks. These are valid practices, and ensure efficiency when the trade involves a *specifiable*

[126] A higher effort requires higher mental effort and or more sweat to ensure on-schedule delivery, high quality, and so forth.

object of delivery, and the principal can at a low cost *observe and verify* whether the contractor conforms to the specifications.

However, the problem in the construction industry seems to be that it is typically very difficult for the government to judge the quality of the contractor's efforts, even when short-term fragmented works and services contracts are used. Whether or not the contractor's efforts conform to the specifications of the government can typically be determined only after a significant time, typically outside of the warranty period. In other words, even though the contractor risks being punished, the probability p of being caught shirking, i.e. choosing e, is so low that it can be very appealing to avoid the costs c, which accompany exerting the high effort e^*, i.e. $ec > pm$.

It is empirically well documented that construction projects in practice involve recurrent negotiation to accommodate e.g. variation orders, the client is intimately involved in supervising the progress of the project, projects often lead to costly disputes, and quality problems are frequent. In reality the efforts of contractors in infrastructure projects are therefore perhaps not as easily *specifiable, observable or verifiable* as presumed. Because the contractor has no incentive to protect the vested interests of the government, it is actually very likely that fixed-fee and hire compensation mechanisms do not result in efficient contractual relationships.

The equitability of the contract can also be considered as low, because the government typically captures a majority of the surplus the project implies by engaging in competitive bidding. A contract that is highly unfair to the contractor may also in practice be related to the efficiency of the project: A contractor may feel uncommitted to an inequitable contract, which, as a consequence may turn out indurable, leading to costly disputes, i.e. inefficiency.

4.4 Description of Traditional and PPP Infrastructure Production Alternatives

The basic objective of this chapter was to clarify what PPP essentially is, and how it differs from the traditional path of public transport infrastructure procurement. This is also a tension that will later be leveraged to study the relative efficiency of PPP, reduced to the fundamentals of economic theory. The table (Table 3) below summarizes the evidence from the multiple backgrounds that have been reviewed. More specifically, the rows of the table capture the insights gained from project business literature, research on project finance, and the context of public procurement, in light of the theory of industrial organization.

Table 3 Stylized description of polar (traditional and PPP) infrastructure production paths

Dimension	Traditional	PPP
Scale of responsibilities	Minor, partial, subservient deliverables, characterized by a low level of output	Major, whole, self-standing asset, characterized by a high level of output
Scope of responsibilities	Separation and segmentation of design, engineering, construction and operation functions	Unification and integration of design, engineering, construction and operation functions
Duration of responsibilities	Short-term works and services, standard warranty period	Long-term construction works and operation services, lifecycle responsibility
Supplier selection protocol	Competitive sealed bid auction procedure	Mixture of competitive auction and negotiation procedures

Tender specifications	Complete, exhaustive rights and obligations	Incomplete, general output criteria
Compensation structures	Fixed, lump-sum or cost-plus wages	Variable, performance-based fees
Resolution of potential disputes	Reliance on general arbitration mechanisms, contract assumed to be court-enforceable	Establishment of dedicated arbitration mechanisms, contract assumed to be partly self-enforceable
Financing	Direct, government credit-rating-based public finance	Project-specific, asset-based private finance

5 PUBLIC AND PRIVATE FINANCING ALTERNATIVES

Financing is one of the most important functions in PPP, and a key theme in the literature on PPPs. Differences in the cost of capital between the private and public sector are a recurrent topic of debate in research as well as media. The typical argument is that a government can save on debt service costs relative to private companies due to an excellent credit rating. However, debt service costs are only the explicit costs of capital, whereas an economic perspective also includes implicit costs that result from foregone opportunities – the opportunity costs. Prior studies have not embraced this economic perspective, which is why actual differences in the cost of capital between public and private financing alternatives deserve a separate elaboration in this chapter. The chapter is divided into four sections. The first outlines the typical argument against PPP grounded in the advantages of public finance; the second describes the public and private alternatives and sums up the conventional argument more formally; the third shows a flaw in the presumed advantages of the public financing alternative; and the fourth substantiates this result from two other perspectives.

5.1 Debate on Public and Private Cost of Capital

The differences in financing costs are a key theme in academic literature on PPPs,[127] and deserve an in-depth and rather lengthy elaboration. A predominant conception in public discourse, sometimes shared by scholars,[128] is that a PPP project is an expensive alternative for the procurement of infrastructure assets and services, because of PPP's comparatively high financing costs, which are assumed to be ultimately transferred to the government and covered out of tax payers' pockets.

One motivation for this section is to show that this is a false conception, based on basic economic and financial theory. The aforementioned argument typically relies on results gained through hypothetical

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[127] Finnerty 1996; Currie 2000; Franks 2002

[128] Kiiras, Erälahti, Maijala, Tuhola & Töyrylä 2005

calculations and conflicts with both the empirical fact that PPP activity has grown tremendously world-wide as an accepted means of providing infrastructure assets and services under certain circumstances, as well as conclusions that can be derived from a theoretically well-founded analysis, as this study shows.

The purpose here is to doubt the validity of the resistance to PPP based on the cost of borrowing argument and show its weaknesses from a theoretical viewpoint. Financing costs are a highly relevant issue, but not the whole picture, and it is needless that much of public discourse on PPPs revolves seemingly perpetually around the cost of capital. A simple analysis in what follows is sufficient to make the point. With reference to the economic model developed earlier, we will focus the analysis on financing,[129] and more specifically, the cost of capital.

5.2 Description of Private and Public Financing Alternatives

5.2.1 Description of the Conventional Argument

The genesis of the conventional argument, typically favored by politicians, is that a government should fund infrastructure development, because it can borrow capital at a low interest rate. It is very true that infrastructure assets tie up enormous capital, major projects typically in the scale of hundreds of millions in euros, and therefore it is obvious that the costs of debt service make up a significant portion of total costs. It is also true that the governments in well-developed economies have a very low risk of default, having consequently an excellent credit rating, translating to a low cost of borrowing.

It seems intuitively appealing then for a government to use its access to cheap capital to borrow and fund infrastructure development projects. However appealing the practice seems at first thought, it is based on an incomplete or even erroneous understanding of the framework of financial markets in both theory and practice. There is nothing wrong with a

[129] In other words, we will hold social externalities *B,* the required investment *I,* taxes *t* and private revenues *R*, and costs *C* constant.

government borrowing funds on its general credit, which is excellent and therefore the applied interest rate is low. But what happens when a government allocates these funds to an inherently risky venture is, in brief, that the government violates the principles of financial markets, incurring an opportunity cost and subsidizing a certain producer with an amount equal to the implicit costs included in the opportunity cost.

5.2.2 Public Finance and Public Organization

The line of thought needs some elaboration and simple notation. To keep the analysis simple, it suffices to accept a widely held assumption that financial markets operate on the basis of four basic principles discussed earlier in the review of the theory of investment.[130] These principles effectively ensure that capital, a key input and production factor to any economic activity in the widest possible sense, is allocated efficiently. For the purpose of illustration, let us first assume a two-stage model, in which at stage one a government borrows a certain amount of capital denoted by D, at an interest rate of r_f, which is presumably very close to the risk free rate given an excellent credit rating. At stage two the government invests the same amount $I = D$ into a capital-intensive project.

Let us also assume that one such alternative is a public-sector led infrastructure project, which involves constructing a highway and maintaining it for a time span of T years. The infrastructure will be in operation for T minus construction period P, after which it is simply disposed at zero value. Let us also assume that the project is inherently risky, which is a very reasonable assumption for any economic activity. In the case of constructing and operating a highway for a long term, risks arise from material and labor availability and cost, engineering calculations, technological solutions, geological uncertainties, weather conditions, plain human error, and many other possible sources of disturbance to the project execution. The realization of these risks could

[130] See section 2.2.1

cause extra costs, schedule delays, and lower-than-expected performance of the completed infrastructure.

Let us again assume that the construction period *P* is one year, the construction requires an initial investment of *I*, and when completed, having the highway in operation incurs a constant, annual cost of *C*, and having the infrastructure asset and the complementary services required to operate it effectively delivers total annual societal benefits of *B*, where $B > C$. Then, in principle, we could rely on basic investment theory to evaluate intelligently the viability of the project. We would proceed by a standard calculation of discounting the annual net benefits $N = (B - C)$ to the present day and comparing the resulting present value *PV* to the initial investment *I* to determine the net present value *NPV.* For the purpose of discounting, we would need to determine an appropriate discounting factor *r* for each of the periods $I = 1,2,\ldots,T$. Let us assume that the discounting factor is defined by r^i, for each of the periods *i*, respectively. The *NPV* of the project, as a function of *r,* would then be defined as $NPV(r) = \sum(N_i / r^i) - I$.

5.2.3 Private Finance and Private Organization

Let us next assume that there is another party, a private comparable to the public party and willing to consider taking responsibility of the project, in other words constructing the infrastructure and operating it similarly until *T*. The party is a separate private company, with no operating history or assets (except for a minimum equity contribution of *E*). The party would also finance the project entirely on debt *D*, and since $E << I$, we can reasonably omit the effect of *E* in the analysis. Let us also assume that this party has access to the exact same resources and is equally capable of delivering the infrastructure. In essence, the private party could create equal annual societal benefits of *B* at equal annual cost of *C,* and would require equal initial investment of $I = D$. The stream of the net benefits generated by the public and the private party throughout the time span *T* would then be identical, and the net present value as a function of the cost of capital, would be $NPV(r) = \sum(N_i / r^i) - I$ for both.

The next task would be to determine an appropriate discounting factor. In business parlance, it is common to use a figure called the cost of capital r_d as the discounting factor, which in essence captures the uncertainty related to the future *B* and *C* projections. It is a measure of return a business must offer to investors, i.e. what investors expect from a particular venture, all risks considered, within the framework of financial markets. In particular, since r_f is the rate of return expected from a completely risk free investment, the project cost of capital r_d is obviously higher ($r_d > r_f$), since the project, as explained, is inherently risky, and more risk is acceptable only with a higher expected return.

The private party would need to evaluate the project on its own merits and access the financial markets to raise funds for the project as a separate economic unit. Potential debt investors would assess whether or not *C* and *B* projections are realistic, and assuming so, they would be willing to lend an amount *D* of funds at an interest rate r_d, which is a fair rate given all actual risks inherent and other risky investment opportunities available.

5.2.4 Comparison of Public and Private Alternatives

The question then is whether the project should be undertaken by the public or the private party. To evaluate these alternatives objectively, we could use the *NPV* as a standard criterion and require that the alternative with a higher *NPV* should be chosen. It inevitably follows that at stage 2 *the government should invest in the project,* because given its excellent credit rating, the net present value associated with the course of action where the government invests is higher than the course of action, where a private company invests.

More formally, since $r_d > r_f$, it follows that $NPV(r_d) < NPV(r_f)$ – the discounting factor that the private party uses is higher than the government one, and therefore its NPV is lower. In other words, it would make sense for the government to take charge of the project, fund it on its general credit and overtake construction and operation activity (typically using private sector subcontractors, but this is not the point). *This is essentially*

what the argument against PPP and privately funded infrastructure development is.

The argument suggests that it does not make sense to establish PPPs in well-performing economies, such as Finland, because governments typically have an excellent credit rating, and their cost of borrowing is often very closely the benchmark of financial markets, i.e. the risk-free rate of interest. Whereas the cost of borrowing, and especially the cost of equity of a separate legal entity will certainly be subject to a risk premium over and above the risk-free rate, because it is practically impossible to isolate an individual venture from all sorts of risk (e.g. commercial, technological, natural). In other words, PPP is a poor alternative to procuring infrastructure in well-performing economies.

The reverse is true for developing countries with poor national credit ratings and tight budgets. The cost of borrowing on a project basis can provide more leverage and a significantly lower cost of borrowing, leading to a lower WACC, because the project's viability is evaluated as a separate economic entity, with greater independence from the respective economic, political, legal conditions and many other variables, which are typically unfavorable (but which are nevertheless factored into the analysis).

5.3 Analysis of the Explicit and Implicit Costs of Financing Alternatives

5.3.1 Opportunity Cost of Public Finance

However, there is a crucial flaw in the conclusion regarding PPPs in well-developed economies reached above, but it is not necessarily easy to see. It is, nevertheless, obvious that the above conclusion leads to a course of action that violates the principles of financial theory, since *capital is allocated at a risk-free rate to an essentially risky project*. What, in effect happens – and this is the crucial step – is that the government, by investing capital borrowed at the risk-free rate in the project simultaneously incurs an opportunity cost *OC.* In other words, the government does not consider the implicit costs of committing capital resources to a particular use, but

takes into account only the explicit costs of debt service. To quantify the implicit costs we can calculate the opportunity cost and subtract from that the explicit costs of debt service in what follows.[131]

To review, opportunity cost is the value of the best alternative use of the resources, in this case pure capital. Basically, there is an infinite variety of alternatives that the financial resources could be put to, but it is not possible or meaningful to consider the whole universe of alternatives, if we assume that a government has determined that a certain infrastructure asset would be beneficial from a social welfare viewpoint. However, one obvious alternative that should not be overlooked in this context is pure, financial investment, which represents a relevant comparable, alternative course of action the government could follow.

In other words, the government could choose to use the resources I for investing in an efficient portfolio of risky assets with an expected rate of return r_p in the financial markets. The government, in essence, would function like any bank, taking in funds amounting to $D = I$, for which it pays an interest rate r_f, and subsequently investing these in an efficient portfolio of assets that generate an expected rate of return $r_p > r_f$. The government would thus be expecting revenues of $R = I(r_p)$ each year, debt service costs of $I(r_f)$ each year, and making an expected investment profit of $\pi_i = I(r_p - r_f)$ each year.

Then exactly how high is r_p? To answer this question, suppose next that the hypothetical debt investors who consider investing in the project are also able to access funds at the risk free rate of r_f,[132] and since we assume that they are willing to finance the project by providing debt capital at a rate of r_d, they are expecting revenues R of $R = I(r_d)$ each year, debt service costs C of $C = I(r_f)$ each year, and making an expected investment profit π_d of $\pi_d = I(r_d - r_f)$ each year.

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[131] See section 2.1.3

[132] Typically banks are able to access funds at an even lower rate. The interest that banks pay to consumers and firms that make deposits, their main source of funds, is lower than the prevailing risk-free interest rate.

Then the government, in considering functioning like a bank, should be willing to invest in the project if it is offered the same rate of return r_d that other debt investors expect from this venture, considering all the risks inherent in the project projections. Therefore, the government should be indifferent between investing in some other portfolio of assets and investing in the project, if $r_p = r_d$.[133] And *the periodic opportunity cost* of investing itself in the project, and not in a portfolio of assets, *is equal to the revenue foregone, OC = I(r_d)*. Moreover, the total *OC* over the life of the project is *I(r_d)^T.*

5.3.2 Implicit Costs of Public Finance

The government, by investing itself in the project, thus foregoes the opportunity of receiving revenues of *I(r_d)*. Its periodic explicit debt service costs are, given an excellent credit rating, still defined by the risk-free rate r_f of borrowing, and amount to only *I(r_f)*. However, the opportunity cost just calculated includes both the explicit and implicit costs, and therefore the periodic *implicit costs of investing itself in the infrastructure project* are defined by $I(r_d) - I(r_f) = I(r_d - r_f)$, where $r_d > r_f$, because *the project is inherently risky*. The total implicit costs of the government investing in the project are thus defined by *I($r_d - r_f$)^T, and are essentially equal to the customary conception of differences in private and public sector cost of capital.*

> *This implicit, economic cost is typically ignored in PPP analysis, and explains – moreover quantifies – the apparent cheapness of sovereign funding.*

The figure (Figure 21) below illustrates the line of thought. At stage 1, the government borrows *D,* at the risk-free rate, shown by *(1).* At stage 2, the government leaks the funds at the same cost to a public party to invest in a risky infrastructure project, denoted by *(2).* The government simultaneously incurs an opportunity cost, because given that the

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[133] The rate r_d is essentially also the rate at which the private supplier can raise capital.

government has access to cheap capital, it could have at stage 2 chosen to invest the same capital amount in an efficient portfolio of assets, which provide an expected rate of return $r_p = r_d > r_f$, denoted by *(3)*.

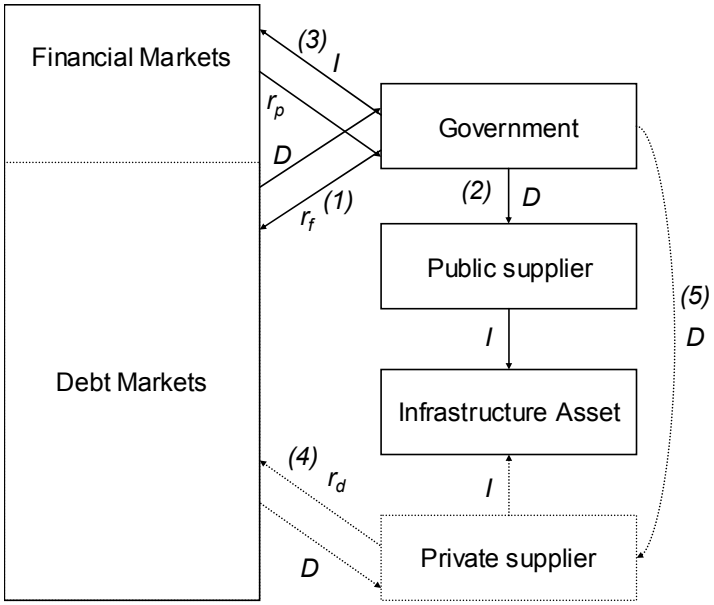

Figure 21 Illustration of the implicit costs the government incurs

By choosing to forego this investment opportunity, the government therefore loses a lucrative opportunity to make an investment profit. If the government were a typical rational, risk-averse, insatiable investor, and a responsible governor of citizens' funds, it would, like everybody else within the framework of financial markets, be indifferent between investing in the infrastructure project, which has a risk level captured in r_d, or investing in an efficient portfolio of risky assets, which provide an equal expected return of r_d. The rate of return r_d is consistent with what outside investors would expect from this particular infrastructure venture, all risks considered, within the framework of financial markets, denoted by *(4)*.

5.3.3 Competitive Market Perspective to Public Finance

What happens from the perspective of the private supplier candidate is that the government intervenes in the construction market and favors a public producer, usually a government agency, by supplying it with unnaturally cheap capital, which in the case of a capital-intensive infrastructure project represents a key production factor and a decisive competitive advantage,

equal to the government's implicit costs of capital. *This is nothing else than a form of subvention, which, in fact, is prohibited by competitive legislation.*

Economic theory attests that it is beneficial for a social planner, i.e. the government, to ensure that certain public goods such as highways are provided, but economic theory also promotes fair competition and that for any given purpose the most efficient means are chosen. Our analysis so far assumes that the public and private parties are identical in their capabilities, so it is awkward that the analysis automatically leads to choosing the public alternative. In fact, this is wrong: there is no reason why a government should favor a public party over a private party when alternatives are available, and the government is effectively violating sound economic principles captured in legislation as well. The government could, in principle, borrow on its general credit and leak the funds at the same cost of capital to the private party, which would ensure a fair competitive setting, which is shown by arrow *(5)* in the figure above.

5.4 Further Illustration of the Implications of Public Finance

5.4.1 Description of Approach

This conclusion is an inevitable, logical result from the analysis taken, when the concept of opportunity cost is factored into the analysis. However, to illustrate the rationale of the result further, it is possible to explore the implications of a counter-assumption. In other words, let us assume for a while that the practice is economically sound and a good basis for public policy.

To make this point absolutely clear, it is helpful to use an extreme example of financing *all* economic activity on a general government rating. In other words, to study the implications of extending the same practice from an arbitrary infrastructure project to all projects concerned with economic activity. This is a hypothetical, but similarly practically appealing opportunity, because, in essence, a government could be tempted to

stimulate investment and total production leading to increased welfare by providing all domestic businesses with low cost capital.

5.4.2 Consequences of the Unconsidered Implicit Costs of Public Finance

The appeal is that the government could borrow on its excellent credit rating and subsequently leak these funds at the same cost of capital to all private firms. However, should this occur, the international financial markets would eventually realize the actual risk inherent in the governments deteriorating loan portfolio, which would obviously include some very risky ventures (stimulated, partly, by cheap capital), lower the general credit rating of the nation as a consequence, and thereby correct the pricing of capital inevitably. *Thus, by the logic of induction, because the practice is undesirable if extended indefinitely, it follows that the practice must be undesirable for a singular case too*. Where alternatives are available, a government should not arbitrarily subsidize some economic parties by allocating funds at a lower cost than is fair within the framework of capital markets: The cost of capital must reflect the actual risk involved.

Of course a single infrastructure investment is insignificant on a national scale and thus has little effect on the general rating of a nation and cost of borrowing. However, despite the practical appeal, the main theoretical problem remains plain: by financing projects on a general credit rating, a government may distort the cost of capital used to finance individual ventures, promote unfair competition, and taken to extreme would eventually result in an average (higher) pricing of loans through the mechanism of credit rating within the international financial markets. As already noted, economic theory does insist that it is beneficial for the government to intervene and ensure certain economic activity, but in comparing alternative arrangements to organize this activity, a public or any other alternative should not be favored by supplying it at an unfair price of capital.

From the perspective of a private PPP candidate the government effectively favors a public party by supplying it with unnaturally cheap

capital, which in the case of a capital-intensive infrastructure project is a decisive competitive advantage, and in fact equal to the government's opportunity cost. By confusing its role as a social planner and a producer unit, the government distorts the functioning of markets. *A public option may not be economically the most low-cost alternative, but it is nevertheless chosen when low-cost capital offsets higher production costs.*

The practice however practically appealing is simply not economically sound. The reliance on the government's excellent credit rating and funding of infrastructure does not deliver *a free lunch.* To finalize the argumentation, let us once more illustrate this idea, this time with a slightly different representation (Figure 22).

A government is tempted to think that it can benefit a domestic economy by borrowing funds from the international financial markets *(1)*, leaking these resources to a producer *(2)*, who invests these in a venture *(5)*, which in this case is an infrastructure project.

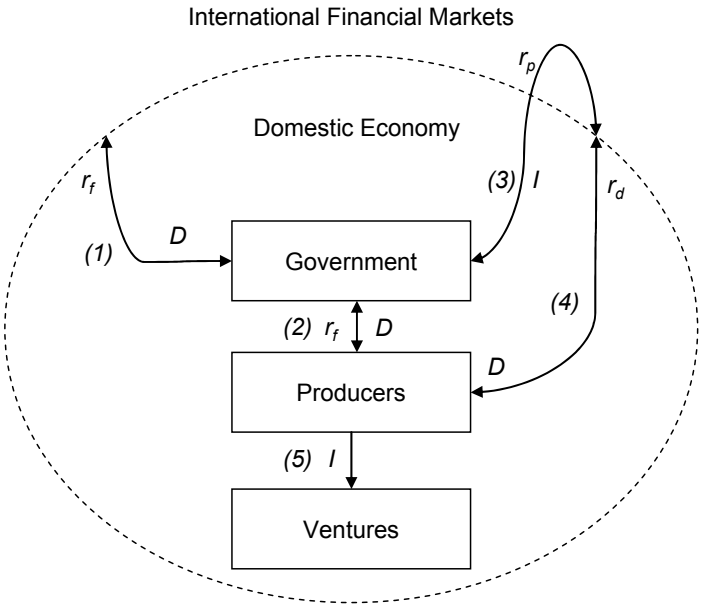

Figure 22 Summary of paths available to finance the production of infrastructure

The appeal is that a domestic economy saves on debt service costs, because it needs to return only an interest of r_f on the debt capital the

government raises, where as it should return a higher r_d on the debt capital that a private producer would raise *(4)*. The glitch, however, is that the government could produce the exact same outcome by borrowing *(1)* and subsequently investing *(3)* the funds in the international financial markets. The domestic economy would in this case make an investment profit that offset precisely the higher costs of debt service that a private financing alternative incurs. The domestic economy does not benefit from financing tricks – the economy relies on fundamental production efficiencies.

5.4.3 Equitable Comparison of Public and Private Suppliers

The government's low default risk and low-cost capital is grounded in government ability to raise taxes. Assuming a public producer is less efficient than a private alternative, higher production costs are paid out of taxes and if risks materialize, additional tax funds are routed into the project to cover the resulting costs. In a PPP, the expected costs of risk are captured in the cost of capital, and the expected economic performance is captured in B and C projections.

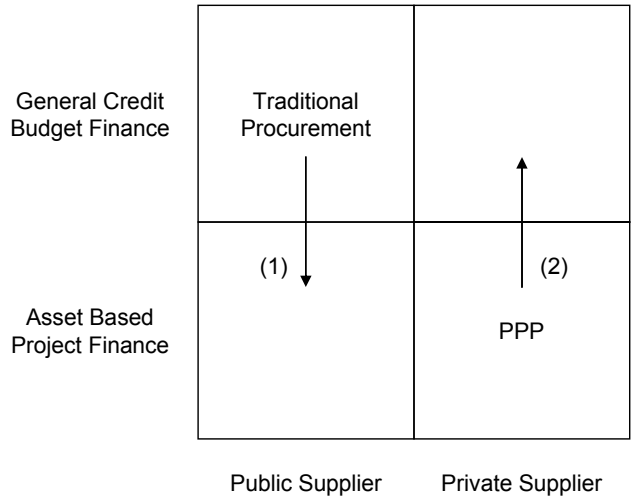

Figure 23 Level evaluation of public and private supply alternatives

To evaluate a public and private led production on a level, fair basis, the government should, itself, finance on a project basis (1), or allow the private party access to the low-cost funds available on the government's credit rating (2). The figure above (Figure 23) illustrates this idea.

Although this practice would make the alternatives fairly comparable in production cost terms, it would still not account for transaction costs – most importantly the contractual hazards that arise from information asymmetry between the government and suppliers, *but also the contractual inefficiencies that may be prevalent in government agencies*.

6 COMPARATIVE EFFICIENCY OF PUBLIC-PRIVATE PARTNERSHIP

PPP is a relatively novel means of organizing economic activity and stands in rather stark contrast to traditional paths of public procurement. Consequently, PPP is subject to significant on-going debate in Finland and elsewhere in Europe. Although the comparative efficiency of PPP can ultimately be answered only through empirical studies, a number of arguments against PPP have been developed, based on hypothetical calculations. Because hypothetical calculations employ multiple assumptions, which are not necessarily accurate, a theoretically well-founded study is warranted to inquire into the underlying economics of the phenomenon to develop clarity and in-depth understanding of PPP, and to provide a strong foundation with which to evaluate the validity of hypothetical calculations and guide empirical research in the future. The first section of the chapter reviews the logic of comparative evaluation of different alternatives to organize the production of infrastructure goods. The second section derives four propositions on the comparative costs of PPP versus traditional paths of public procurement. The third section takes these propositions as given and presents two more propositions on the implications regarding the efficiency and equitability of PPP.

6.1 Logic of Comparative Evaluation

The PPP scheme is best understood and evaluated in comparative terms, in other words as a distinct alternative among other available opportunities. As Williamson has noted in more general terms within the framework of transaction cost economics, there is no universally optimal mode of organizing economic activity.[134] The challenge is to select the cost-minimizing arrangement from multiple alternatives for any particular activity, in this case, the delivery of transport infrastructure assets and services. Since we already know that the cost of capital is not a valid basis for choosing between alternative procurement paths, we can focus the

[134] See e.g. Williamson 1991

analysis on the underlying production and transaction cost economics of the available alternative approaches.

To start off, we should keep in mind that we are concerned with evaluating two polar paths of action that can be followed to produce transport infrastructure, which is best characterized as a *common capital experience good*. From the inquiry into PPP and comparable traditional public procurement, we have already characterized two paths, representing *traditional procurement* and *PPP*, on basis of certain key dimensions (Table 3). We will next evaluate the two on the basis of the *costs* of *production* and *transaction* that result from following either course of action.

The analysis of the differences in *private* (production) *costs* and *transaction costs* between alternative courses of action*,* translates to a theoretically valid analysis of *relative efficiency,* which is a key concern that has emerged in PPP literature. The concern is whether it makes sense to organize the production of infrastructure assets and services through a PPP, taking into account both the costs of inputs as well as all the costs beyond the price paid inputs – the transaction costs. In other words, can PPP produce the same societal benefits that a transport infrastructure generates at a lower productive and contractual cost than the traditional approach?

With the model of PPP in mind and a representation of the traditional approach, we may begin to inquire into possible causes of differences in the terms *C,* i.e. private (production) costs,[135] as well as the transaction costs of enacting the whole production scheme in either alternative approach. To review, the private costs refer to operating the facility and exclude any negative externalities such as pollution, and the transaction costs refer to all other costs beyond these.

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[135] Moreover, the study of any factor related to positive externalities *B*, could in fact be formulated as a study on the differences in cost, given a higher or lower level of societal benefits *B**. In other words, study differences in *C,* holding $B^* = B + \Delta B$ constant.

Ultimately, differences in these costs can be quantified only through empirical research, but it is beyond the scope of this study to subject these concerns to empirical analysis. Nevertheless, given the relatively recent introduction of PPP schemes and their evident complexity, there is not as yet a disciplined inquiry into the subject, which motivates the formulation tentative propositions on the relative efficiency of PPP – it seems further research could benefit from a set of disciplined propositions to direct further studies.

In order to make a valid comparison, it is also important to also keep in mind that in the traditional procurement approach, any given infrastructure asset and services are produced by a composite of multiple smaller works and services projects, in both physical and temporal scope. Therefore, we are not comparing PPP with some arbitrary, minor, works or services project; instead, we hold the production of some major transport infrastructure constant and view the two paths as two distinct alternatives to implementing that good.

Let us denote the traditional path as Design-Bid-Build (DBB), which refers to a typical scheme, where the government procures design or planning separate from implementation, which is subsequently awarded through competitive price bidding to the lowest bidder. The comparable DBB scheme approach thus involves multiple smaller projects and recurrent contracting over the life of a major, long-term infrastructure facility.

6.2 Propositions on the Comparative Costs of PPP

6.2.1 Production Costs

Physical Scale and Scope

First, we know from the technological view of the firm that the enlarged physical scale that is associated with the integrated nature of PPP may provide opportunities for technological synergies, which contribute to lower total costs. Technological synergies are achieved by a decrease in the production cost of a single unit of output (economies of scale) in a single product firm, or a decrease in the production cost of a single unit of

output in a multi-product firm (economies of scope). In both cases technological synergies result in a lower total cost, and the concept is captured in the concept of subadditivity, which encourages gathering separate activities within a firm, i.e. integrating separate economic activities.

In contrast to traditional, fragmented procurement, PPPs involve a single point of responsibility for all the functions and facilities that are necessary to constitute an economically independent, viable operating entity. Almost by definition, a PPP project must be broad enough in physical scope to be able to cover the fixed costs of establishing and running a separate capital asset. Integration of physical and functional responsibilities can lead to significant improvements in economies of scale and scope contributing to lower costs and thereby increased productivity. For a project of any given physical scale and scope, PPP allows better opportunities to exploit technological synergies, because the traditional approach breaks the end deliverable into a number of sub-projects. This recognition allows us to formulate the first proposition:

> *Proposition 1: The comparative unit production costs of PPP are negatively related to the physical scale and scope of the project*

In both schemes, unit production costs, in absolute terms, are negatively related to the physical scale and scope of the project. However, the proposition states that the unit production costs of a PPP scheme fall by a greater absolute amount as the project size increases. If we were to study a unit cost differential, defined by the production costs of PPP minus the production costs of the traditional path of procurement, as a function of the project size, the differential would plot a strictly decreasing line. In other words, the cost advantage of PPP would increase in the increasing direction of project size.

First, the fixed construction site costs would be reduced as a result of avoiding duplicate machinery, site accommodation and related services. Second, it is also possible that a private-sector party could be able to

reduce organizational bureaucracy and associated overhead costs. Third, resulting from a broader object of delivery and associated higher material needs, the supplier would enjoy higher bargaining power leading to unit material cost savings. Fourth, the integration of design, engineering, construction and operation responsibilities could allow for economies of scope, reducing e.g. lifecycle capital expenditure.

Construction industry wide failures to achieve substantial increases in productivity have often been attributed precisely to shortcomings in dealing with the fragmented structure of the industry. Project business literature views the integration of traditionally fragmented activities into broader packages advantageous. Similarly, empirical evidence to date suggests that PPP is appropriate where there are major capital projects with significant ongoing maintenance requirements.

Moreover, other mature utilities industries such as oil and electricity that are characterized by a low pace of technological development involve highly consolidated producers. Even more technologically advanced markets, such as the telecom infrastructure, are typically served by very large players. In contrast, the road infrastructure market is surprisingly fragmented, but understandable with reference to segmented government procurement practices. In any case, comparing the road infrastructure market to markets with similar characteristics, suggests that the market exhibits opportunities for technological synergies and therefore it is reasonable to assume that a trend towards more integrated projects will continue.

Temporal Duration

We also know from the complete contracting view of the firm that a long-run relationship may provide opportunities for idiosyncratic investment in dedicated capital, and consequently, cost savings. PPP concessions involve a single, long-term point of responsibility to design, engineer, construct and operate all the functions and facilities of a major project. A PPP project must operate temporally long enough to be capable of standing alone as an economically independent unit in a going concern and

returning the capital to investors. This long-run nature of PPP seems ideal to induce investment in specialized capital to yield surplus gains.

In the traditional approach, a supplier has almost no possibility, let alone incentive, to make project-specific investments in specialized capital. Any bid that would incorporate such *specialized* investments would seriously risk losing the project. Thus, for a project of any given physical scale and scope, PPP allows better opportunities to invest in specialized capital, because the traditional approach employs short-term works and services contracts, which allows us to formulate the second proposition:

> *Proposition 2: The comparative unit production costs of PPP are negatively related to the temporal duration of the project*

Again, the proposition states that the total production costs of a PPP scheme fall by a greater absolute amount as the temporal duration of the project increases. If we were to study the cost differential, defined by the production costs of PPP minus the production costs of the traditional path of procurement, as a function of the temporal duration, the differential would plot a strictly decreasing line. In other words, the cost advantage of PPP would increase in the increasing direction of project duration.

This argument can be backed by a number of considerations. First, because the project company will bear the costs of operating the asset for a long-run it is motivated to make front-end investment in *high-quality design, engineering, equipment* and *materials.* Second, as an example of investment in human capital, a PPP makes is possible to hire professional management to run a separable company and allow them to specialize in managing the asset. Management's relative abilities typically differ across businesses and a separable project company can have the benefit of *managerial specialization*, compared to management managing a portfolio of assets. Third, employees, who are assigned to operating the asset, may increase their efficiency through *learning by doing* during a longer time horizon.

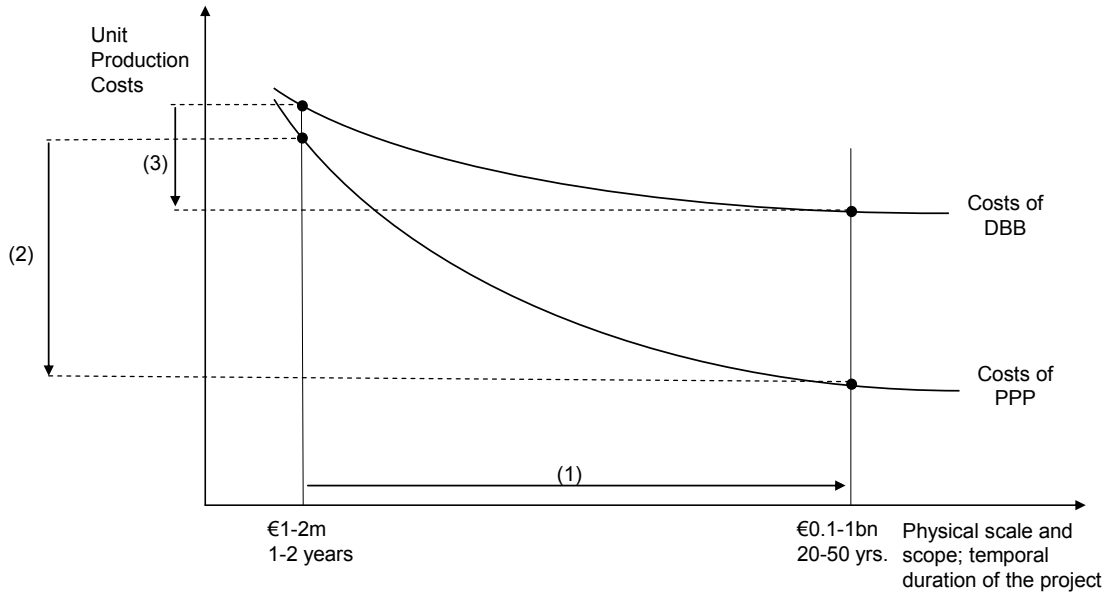

Figure 24 Illustration of the comparative production costs of the alternatives

The joint effect of these propositions is schematically illustrated in the figure (Figure 24

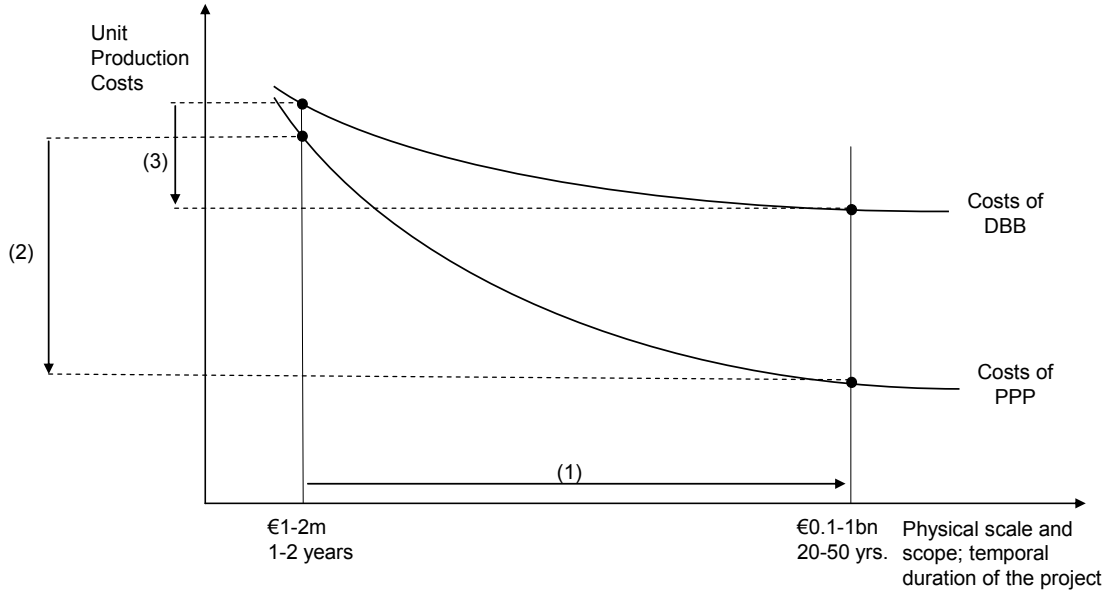

Figure 24) above. The logic of the figure is to signify the increasing physical scale and scope, as well as the increasing temporal duration on the horizontal axis. Physical scale and scope is captured in a euro value proxy of a project and temporal duration is represented in years.

The vertical axis represents unit production costs *UPC*, i.e. the total of *variable* and *fixed* costs per one transportation passage along a highway route ($UPC = c + F / q$) . The two solid lines falling to the right represent the unit costs associated with either DBB or PPP at different project sizes and durations. The basic idea is that a significant increase in the project size and duration (from €1-2m and 1-2 years to €100-1000m and 20-50 years) denoted by arrow (1); decreases unit and fixed production costs by a greater amount when arranged through a PPP scheme (2), than when arranged through traditional procurement practices (3).

6.2.2 Transaction Costs

It seems there are, indeed, better opportunities to exploit economies of scale and scope as well as to invest in specialized capital that yield long-run cost savings in PPP. However, the main point predicted by the theory of industrial organization is that these cost savings are inevitably offset to some extent by an increase in the transaction costs associated with writing contracts under progressively more difficult circumstances, i.e. with more sizeable projects and longer-run contracts.

Another problem with sizeable projects and long-run contracts is also that due to cognitive constraints and unforeseeable events, it may be impossible or highly costly to design contracts that account for all contingencies.[136] However, for the purpose of maintaining clarity and simplifying the analysis, let us hold complexity and uncertainty constant. That is, we will not explore the implications of increasing complexity and uncertainty to neither the traditional approach nor PPP. Nonetheless, the basic point is that increasing the scope of physical and temporal responsibilities are likely to result in production cost advantages, but an increase in complexity and uncertainty yields only additional transaction costs.

In principle, an increase in the transaction costs associated with a more sizeable and longer project is unavoidable. However, the common motive

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[136] As the Anglo-Saxon legal tradition calls for.

of minimizing costs still applies, and there are alternative contracting paths that can be followed to minimize transaction costs under progressively more difficult circumstances. Foremost, the costs of contracting can be broken down into components. The costs of crafting more detailed contracts have to be weighed against the possibility and costs of inducing the same effort by incentives, or the costs implied by employing arbitration mechanisms to complement incomplete contracts. Nevertheless, the point is that an efficient contractual relationship minimizes transaction costs.

As the project size and duration increase, it seems that a PPP concession makes proper use of the transaction cost minimizing contractual mechanisms advocated by theory; whereas the contractual mechanisms of the traditional approach seem inappropriate. In a long-run setting that exploits specialized capital and where contracts are complete, efficiency in contracting is achieved through monitoring to reduce information asymmetries; or incentives to induce desirable effort when monitoring is costly or impossible. In a dynamic setting, where contracts are incomplete, even monitoring and incentives cannot sustain efficiency, and arbitration mechanisms for adapting the agreement as conditions change must be used along with reliance on monitoring and incentives. A PPP concession is incomplete, signed for the long-run, and makes heavy use of positive incentives, and dedicated arbitration mechanisms to augment contract monitoring. These ideas allow us to formulate another specific proposition, drawn directly from the theory of industrial organization:

> *Proposition 3: The comparative transaction costs of PPP are negatively related to the physical scale and scope, and the temporal duration of the project*

Again, the proposition states that the total transaction costs of a PPP scheme fall by a greater absolute amount as the physical scale and scope, and the temporal duration of the project increases. The critical difference in contrast to the propositions regarding production costs – which are always lower, in absolute terms, given any project size and duration – is

that under rather simple contracting circumstances, the traditional path of procurement results in lower transaction costs, in absolute terms.

This is a reasonable assertion, because the traditional approach favors segmented works and services and short-term responsibilities, where the object of delivery is easier to specify, the simple practice of competitive sealed bidding can be used, monitoring is presumably easier, and unforeseeable contingencies leading to costly disputes are less likely. On the other hand, in a PPP setting, even under rather simple contracting circumstances, the government and the supplier(s) always first engage in costly bargaining; and second, in costly drafting, monitoring, enforcing and even adapting of rather long and detailed contracts that ensure their vested interests are protected. This means that the transaction costs of a PPP scheme are higher, in absolute terms, under rather simple contracting circumstances associated with a small and short-term project.

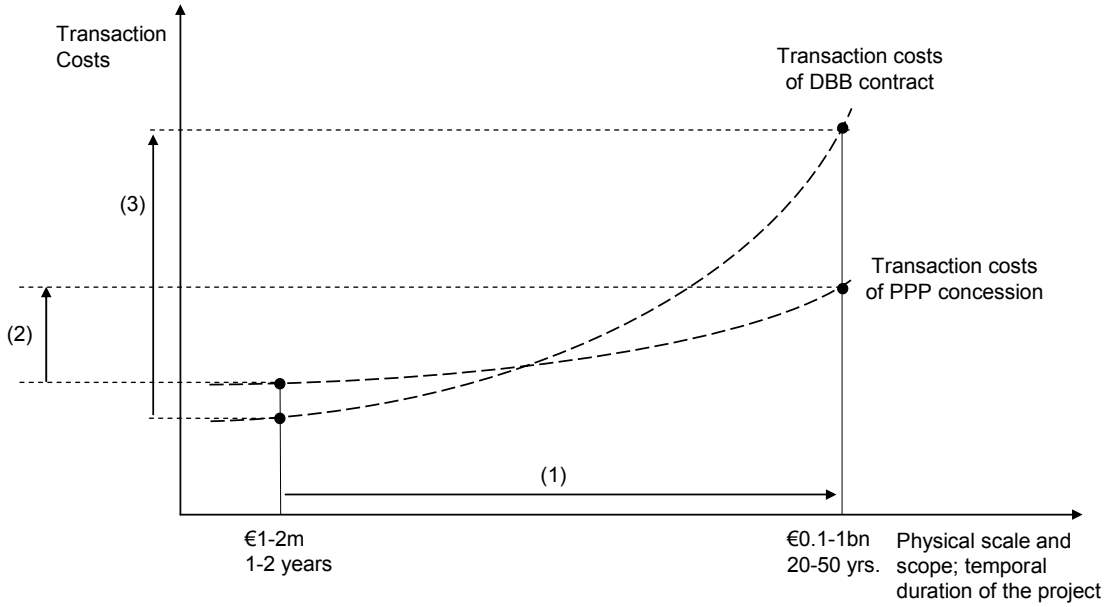

Figure 25 Illustration of the comparative transaction costs of the alternatives

The figure (Figure 25) above again illustrates these ideas schematically. A shift on the horizontal axis (1) inevitably increases transaction costs *TC*. However, the contractual mechanisms associated with a PPP concession result in a smaller increase (2), than the ones associated with the traditional

path of procurement (3). However, the curve representing the transaction costs of the traditional approach starts off at a lower level, and at some point the paths are equal from a transaction cost perspective. The justifications for these views are elaborated in more detail in what follows.

Monitoring Mechanisms

First, with regard to specifications, PPP does not seek contract precision from the outset, so as to save on contracting costs and provide flexibility over the life of the project. The procurement of infrastructure assets and services through competitive sealed bidding is problematic, when projects are very large in physical scale, long in temporal duration, and when all future contingencies are impossible or too costly to specify. In particular when uncertainties remain on technical options to be retained, it may be undesirable or impractical to prepare complete technical specifications in advance. A client may not know the best specifications in the first place, let alone the best options that become available over time. PPP therefore starts out with general output specifications and with incomplete contracts, which promote dynamic adjustment in the contract over time.

Another important condition is that the existence of a stand-alone economic unit and its exposure to the discipline of capital markets contributes to proper monitoring. The exposure to the discipline of capital markets ensures that PPP projects are properly planned and evaluated in advance, and monitored continuously during construction and operation. Before delivery, lenders impose strict due diligence requirements, appointing, for example, technical consultants to ensure all cost calculations are robust, and market consultants to ensure that revenue forecasts are realistic, etc. contributing to proper specification. During delivery, lenders within will also require regular information updates which helps identify and prevent potential problems. Finally, management will be under continuous assessment, and under-performing management is likely to be identified and replaced.

With regard to the traditional path of procurement, the associated competitive bidding protocol, and resulting lump-sum and cost-plus

contract types assume that the contractor's efforts are *specifiable*, *observable* and *verifiable* by the government. Under these conditions, the government could in principle choose the desirable level of effort and impose it on the contractor, with the threat of the large punishment if the contractor shirks.

However, it is well documented that projects in practice involve recurrent negotiation to accommodate variation orders suggesting that effort is not easily specifiable in advance. Second, clients are typically intimately involved in the progress of the project, suggesting that substantially costly monitoring takes place. Third, projects often lead to costly disputes, suggesting that performance is not easily verifiable in front of court. Finally, quality problems are frequent, suggesting that either specification or observation is difficult.

The basic problem is that in reality the production of infrastructure goods is concerned with experience goods, which exhibit durable information asymmetry. In other words, it is typically very difficult for the government to specify, monitor and verify even works and services contracts, i.e. to determine and assess the contractor's actual efforts. Whether or not the contractor's efforts conform to the specifications of the government can typically be determined only after a significant time, typically outside of the warranty period. This means that fixed wage compensation mechanisms are bound to result in efficient contractual relationships.

Incentive Mechanisms

With a stand-alone economic unit it also is possible to design compensation schemes that align more closely the objectives of the firm's client, professional managers and its investors. When managers have a direct share in the profits of a project, they can be strongly motivated to make decisions that enhance its profitability, either by lowering costs, or improving revenues. These profit sharing incentives can take e.g. the form of bonuses that were discussed in the section on agency theory.

The typical PPP payment structure, based on output specifications and usage, contributes to aligning the interests of the lenders, the management, the project company and the public sector. Debt and equity returns can only be guaranteed if the project operates satisfactorily, i.e. the client receives benefits, pays for the service, generates revenues for the sponsor, and allows service of debt and returns on equity. This contributes to addressing the divergent, if not confrontational agendas of the multiple participants, which are often seen as the root cause the construction industry's traditional, major problems such as costly disputes. Moreover, higher managerial incentives can contribute to early completion and thereby higher usage and availability.

During operation, *yardstick competition* allows comparing the performance of PPP management with other managers in similar situations and filtering out effects of random factors, such as changes in demand or costs of inputs. The shareholders may oversee, for example, two similar PPP projects that serve markets with correlated demands or costs. The possibility of being caught underperforming, incentivises management to exert higher effort, which is not as likely in the public sector.

Moreover, firms in a *competitive environment* are more hard-pressed to reduce costs and end up being more efficient. For example government units, which are financed on a budget-basis, typically have no incentive to improve efficiency if there costs are simply covered out of tax-payers' contributions. The shareholders of a competitive PPP firm can base managerial rewards on the competitor's profits, which would not be possible if there are no competitive references.

The traditional approach makes no use of variable compensation schemes. Therefore, we should be critical about the efficiency of the contractual mechanisms associated with traditional procurement even under simple circumstances. Even if transaction costs are lower, in absolute terms, due to simpler contracts, the traditional path of procurement may not *minimize* transaction costs, i.e. make proper use of contractual mechanisms.

Efficiency should be ensured, most importantly, by inducing effort through long-run incentives, when information asymmetry prevails for a long time.

Moreover, in contractual relationships that employ sanctions, even though the contractor risks being punished, the probability of being caught shirking is so low that it can be very appealing to avoid the costs, which accompany exerting high effort. Moreover, a contract procured through competitive bidding that is especially unfair to the contractor may also in practice be related to the efficiency of the project: A contractor may feel uncommitted to an inequitable contract, *which, as a consequence, may turn out indurable, leading to costly disputes, i.e. inefficiencies.*

Adaptation Mechanisms

The approach in PPP promotes a new balance in the contractual effort over time. It seems to be advantageous not to seek precision at all costs from the outset, so as to save on contracting costs and provide flexibility over the life of the project. [137] In the preparatory phase, it is not advised to advance the design studies too far before selecting the supplier, since the preliminary design may be quickly superseded and will, in any event, overlap with the chosen supplier's input.

When long-term contracts cannot forecast all project parameters with accuracy, contracts must stipulate arbitration or discussion clauses to handle situations in which the PPP's initial hypotheses prove invalid. Every potential scenario cannot be anticipated ahead of time; however, invalid contracts and consequent revisions should not be viewed as project crises. This point is a critical one as contractual adaptation has often been perceived as a failure, as an attempt by the firm to realign the contract to its advantage. Under incomplete contracting, contractual adaptation is nothing more than a normal adjustment mechanism for coping with changes in the initial conditions. Nevertheless, the establishment and use of arbitration mechanisms incurs costs.

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[137] Henry 1997

The traditional path of procurement favors segmented works and services and short-term responsibilities, which basically result in lower transaction costs, in absolute terms, because the object of delivery is easier to specify, the simple practice of competitive sealed bidding can be used, monitoring is presumably easier, and unforeseeable contingencies leading to costly disputes are less likely. We should, however, be critical about the efficiency of the contractual mechanisms associated with traditional procurement. Even if transaction costs are lower due to simpler contracts, the traditional path of procurement may not *minimize* transaction costs, i.e. make proper use of contractual mechanisms.

6.3 Efficiency and Equitability Implications of the Propositions

6.3.1 Efficiency

PPP, from a total social welfare perspective is efficient, when the benefits gained from technological synergies related to a more sizeable project deliverable as well as the opportunities to invest in dedicated, specialized capital and the consequent long-run yields *offset* the higher costs of contracting. The figure (Figure 26) below illustrates the basic line of this thought by combining the two earlier figures in one representation. The idea is that the most important distinction between PPP and the traditional procurement path is a significant increase in the scale and scope of responsibilities conferred to the supplier, as well as the duration of these responsibilities, denoted by the arrow *(1)* on the horizontal axis.[138] The vertical axis, in turn, represents the unit production costs ($UPC = c + F / q$) and transaction costs TC.

[138] The axis thus represents the two axis of the earlier figure (Figure 13) folded on their diagonal.

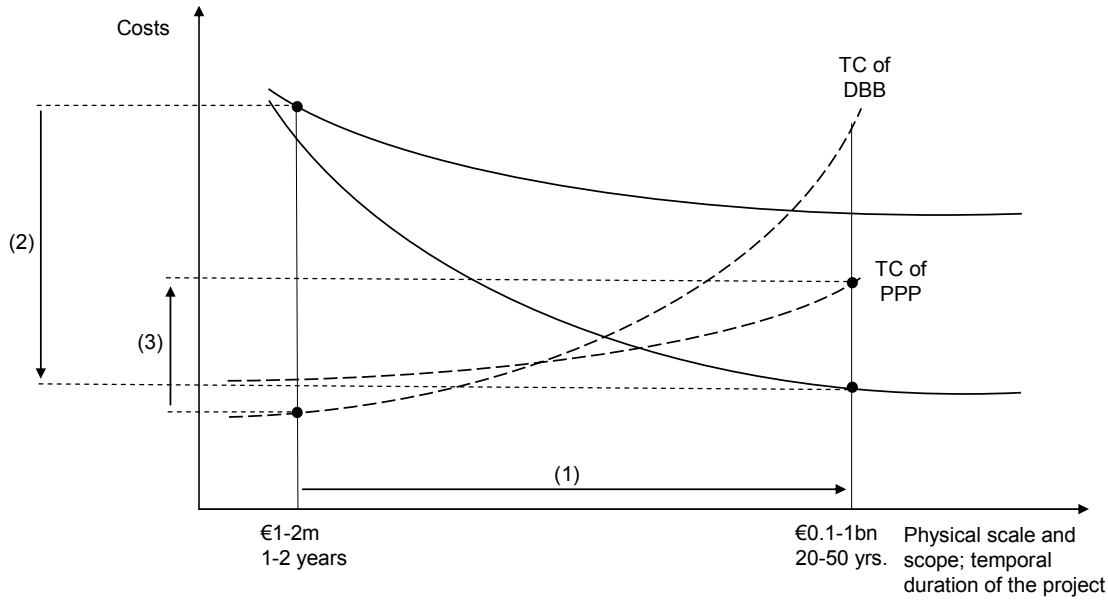

Figure 26 Illustration of the unit production and transaction cost implications of increasing the physical scale and scope, as well as the temporal duration of the project

The solid lines that fall in the increasing direction of the horizontal axis signify the decreases in unit production costs associated with either the traditional approach or PPP. The dashed lines that rise in the increasing direction of the horizontal axis represent the increases in transaction costs associated with either the traditional contracting practices or the PPP concession. The proposition thus states that under certain circumstances the reduction in production costs is, indeed, greater than the associated increase in transaction costs, which means that PPP is comparatively efficient. In other words, a significant shift in the size and duration of the project *(1)* decreases production costs *(2)* by a magnitude greater than it increases the transaction costs *(3)*. This allows us to formulate the next proposition:

> *Proposition 4: There exists a point in the increasing direction of the size and duration of a project at which PPP becomes comparatively efficient*

The figure (Figure 27) below illustrates the proposition, by showing the total *T* of unit production costs and transaction costs ($T = UPC + TC = c$

$+ F / q + TC$) associated with the traditional approach and PPP, as a function of the project size and duration.

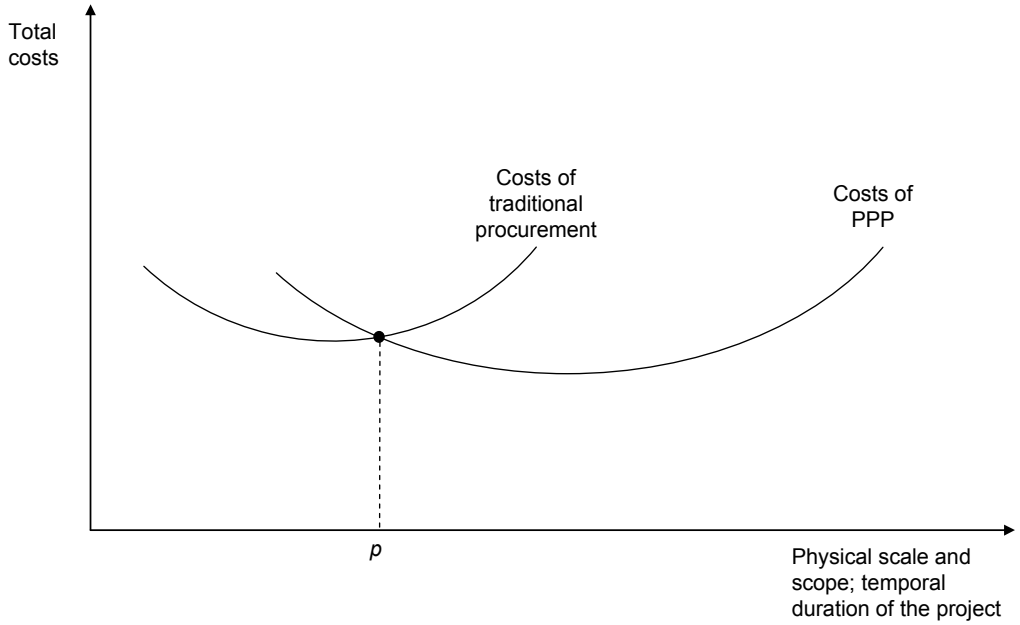

Figure 27 Illustration of the total comparative costs of traditional procurement and PPP

The dashed vertical line signifies a hypothetical point *p,* at which the PPP scheme becomes comparatively efficient. Because the PPP curve falls below traditional one, the figure also attests that due to the opportunities to exploit technological synergies and invest in specialized capital, it would, indeed be beneficial to increase the physical scale and scope as well as the duration of project contracts, as long as appropriate transaction cost minimizing contractual mechanisms are put in place. Nonetheless, the logic does not carry on forever: at some point the transaction related and organizational complexities of managing an utterly large and long project become disadvantageous.

This argument is supported by a substantial increase in PPP activity, as well as a growing body of world-wide empirical evidence, which suggests that with sizeable projects where there are significant on-going maintenance requirements, the private sector can offer project management skills resulting in a greater proportion of assets being delivered on time and to budget, and more innovative design and risk management expertise

to provide better value for money, and to meet the needs and wants of the client better than the traditional models of procurement.

6.3.2 Equitability

Let us next assume that the previous proposition is correct and that we are beyond point *p,* in the increasing direction of the horizontal axis, meaning that due to cost advantages PPP results in a higher net surplus than the traditional path of procurement. In other words, there is a larger cake to be shared. From an efficiency perspective it is irrelevant how the resulting surplus is distributed. In practice, on the other hand, the parties to a trade are likely to be more concerned with their own welfare instead of total welfare – which brings us to equitability considerations.

The figure (Figure 28) below illustrates the higher surplus associated with PPP with an alternative representation. The logic of the figure is to show in the middle the total societal benefits that an infrastructure project of a given size and duration (beyond point *p)* generates during its whole lifecycle, and illustrate the total production costs, total transaction costs and resulting net surplus that organizing the production of the infrastructure asset and services throughout the lifecycle either by PPP (left side) or a traditional scheme (right side) involves. Assuming that the previous proposition is correct, we can next focus on the implications to equitability.

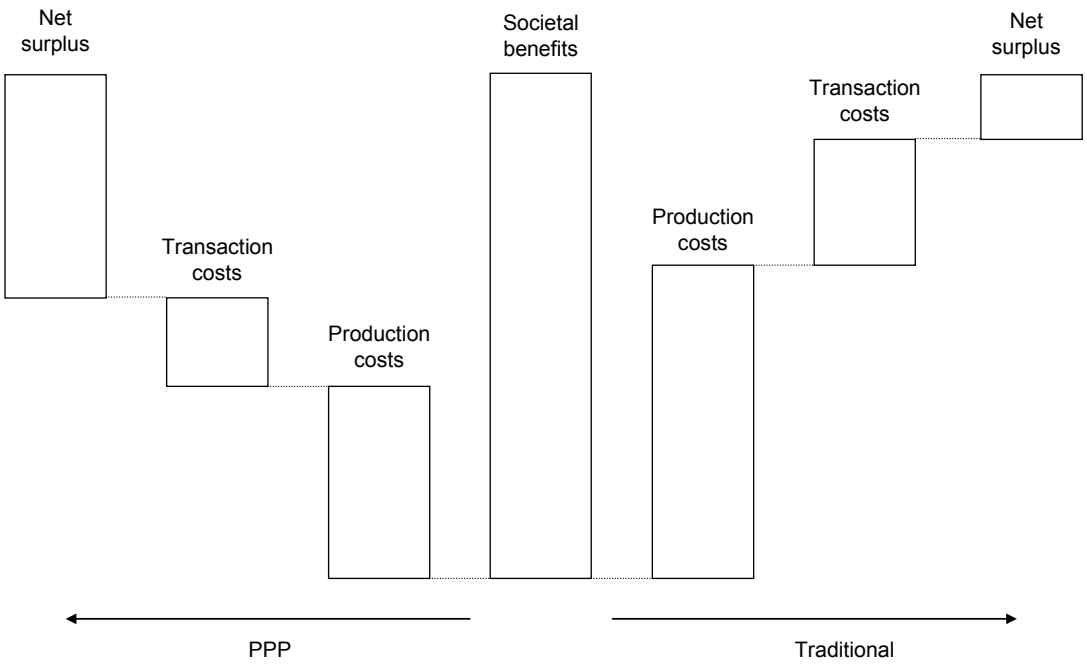

Figure 28 Illustration of the trade-offs between PPP and traditional procurement predicted by the theory of industrial organization

In brief, economic theory also predicts that the competitive-negotiated procedure, the profit sharing mechanism and contract adaptation mechanisms associated with PPP do not allow the government to capture as large a share of the net surplus. In other words, the government captures a *smaller share of a larger cake*, and the supplier captures a *larger share of a larger cake*.

> *Proposition 5: Government captures a comparatively smaller share of the higher surplus associated with PPP*

The figure (Figure 29) below illustrates this proposition in turn. The justification for the proposition is two-fold. First, at the time of contracting, the competitive tension of a partly negotiated procedure is lower than in the pure auction mechanism used in traditional procurement, and therefore the government is unable to "push" the outcome to the proximity of the horizontal axis. Second, in the long run, the government induces the contractor to exert higher effort by sharing some of the societal externalities created with the contractor through a variable wage structure,

which essentially means that the supplier captures even more of the surplus associated with the project.

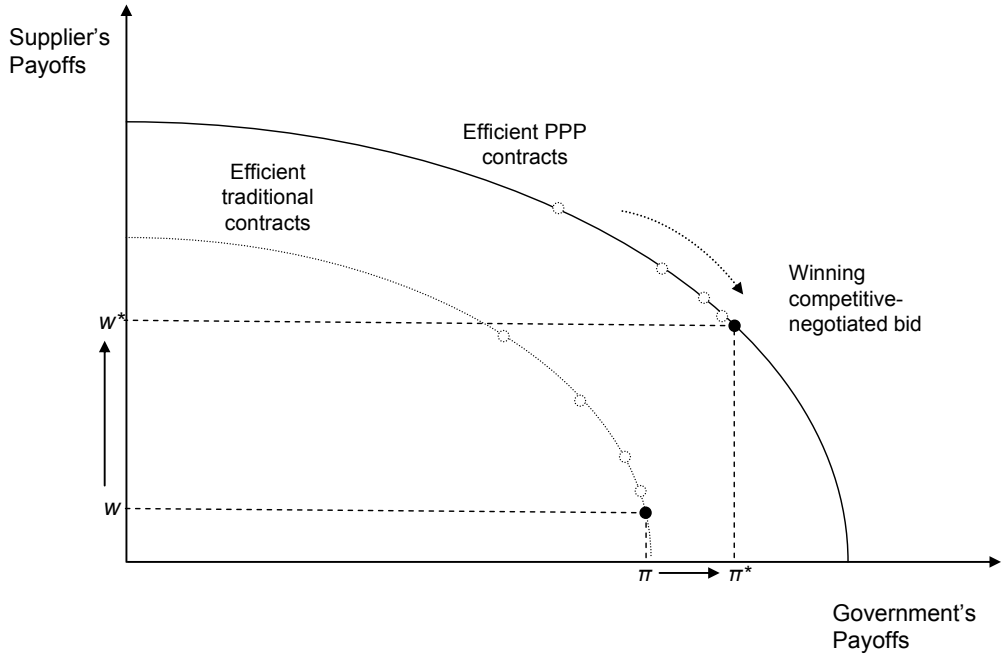

Figure 29 Illustration of the equitability considerations of PPP predicted by economic theory

7 RESULTS

In this chapter the results of the study are presented. The chapter consists of three parts, of which the first focuses on a description of PPP, the second on the differences in public and private cost of capital, and the third on the propositions on the comparative efficiency of Public-Private Partnership relative to the traditional path of procurement.

7.1 Description of Public-Private Partnership

Ultimately, the theories of industrial organization and investment provided a conceptual framework for describing PPP in the study, but the phenomenon was first addressed as a form of project business; second, in view of the discipline of project finance; third, based on a review of prevalent public procurement contracting legislation.

First, the insights on PPP given by the literature of project business were reviewed. A PPP signifies the integration of traditionally fragmented works and services of design, building, financing and operation into more sizeable, broader project procurement and delivery. PPP also represents the development from lump-sum compensation schemes to performance based fees, which help align the interests of traditionally adversial parties in a project. PPP signifies the extension of the construction industry supplier responsibilities from short-term execution to longer-term operation, and a consequent life-cycle responsibility. Finally, PPP represents a higher liberty given to the project supplier to design the project, based on specified output criteria instead of tight, client-defined specifications.

Moreover, empirical evidence to date suggests that PPP is appropriate where there are major and complex capital projects with significant ongoing maintenance requirements. Here the private sector can offer project management skills resulting in a greater proportion of assets being delivered on time and to budget, and more innovative design and risk management expertise to provide better value for money, and to meet the needs and wants of the client better than the traditional models of procurement.

In summary, it seems PPP arrangements, while neither possible nor advisable on all projects, provide a means to address the over-fragmentation of functions that has previously led to divergent - if not confrontational agendas of the multiple participants. While superficially an extension of the design-build mode, i.e. enhanced by the addition of two functions of finance and operation, PPP in reality differs in terms of philosophy and potential benefits, spelling out a significant mind shift and a change in the procurement-delivery paradigm.

Second, the lessons on PPP provided by research on project finance were reviewed. In light of prior theoretical study on project finance, when both direct and project-based financing alternatives are available, project financing is more cost-effective than conventional direct financing when: First, the benefits of a higher degree of leverage; second, the investors' right to control reinvestment of the project's free cash flow; third, the appropriate selection of investment opportunities; fourth, the design of less costly debt contracts; and fifth, an enhanced management *offset* the higher transaction costs and the risk premium that is required.

Third, a public authority cannot arbitrarily choose how it contracts with suppliers; it is subject to juridical constraints, captured in procurement law, which involves responses to three interdependent domains of consideration. First, an appropriate legal framework must be set up to accommodate any given type of contract or selection protocol. Second, a public entity will be required to follow a specified contract award process within the legal framework. Third, a contract must be introduced to bind both parties as an outcome of the selection protocol, within the prevailing legislative framework.

The contracts used in the traditional path of procurement conform to works and services contracts, whereas as a PPP is awarded through a concession – a temporary right to operate an asset. Although there are certain key variations of each contract, the key points are that the scope of responsibilities conferred to any particular supplier in the traditional approach is fragmented and the contract duration is typically 1-2 years,

whereas in PPP, the scope of responsibilities is integrated and the duration is typically 20-50 years. The supplier selection protocol employed in the traditional approach is a reverse auction mechanism, namely the competitive sealed bid, whereas a PPP concession is awarded through a competitive-negotiated procedure.

Fourth, the underlying economics of transport infrastructure production were studied. In economic terminology, a transport infrastructure project involves the production of a durable capital good that creates significant positive externalities over a long-run period, which is why the market fails to provide the good, and which is also the reason it is desirable for a government to intervene and ensure its production, given that the total, social revenues (private revenue plus the value of externalities) are higher than the total, social costs (private costs plus the costs of externalities. In the PPP setting, the road users internalize the positive externalities, and the government prices the externalities by raising various taxes, e.g. vehicle and gasoline, taxes from road users. The government forwards some portion of the tax revenues to the supplier, so that the supplier internalizes some of the positive externalities it generates.

Moreover, it seems essential to highlight that infrastructure is best understood as an experience good. The product characteristics such as quality or total price (cost) are difficult to observe in advance before purchase, but these characteristics become evident upon consumption of the good over its total lifecycle. This experiential quality seems to capture a fundamental problem of the construction business, where the client cannot, in advance easily *observe* or *verify*, sometimes let alone *specify* the characteristics of the unique product in question. The actual characteristics typically become evident only after a substantial time, sometimes only after the standard warranty period is over.

Finally, an economic model of PPP was developed. The model shows the key parties, the key periodic cash flows, the uncertainty of the project reflected in the debt and equity cost of capital. The dynamics and uncertainty of the periodic cash flows in PPP were captured in the

analytical NPV model, as a function of the project risk level, given investment, revenue and cost projections $NPV(r) = \sum(N_i / r \text{ ^}i) - I$

Similar representations of PPP are abundant in literature, but generally speaking they do not provide a unified treatment of the key parties, the key flows of money, a dynamic time conception and uncertainty. The model constructed here addresses all these features and suffices to tie to a single, common basis the themes that have emerged in the literature on PPP, namely value for money (VfM) considerations, relative efficiency of the public and private sector and cost of capital concerns. The first two common themes, namely *relative efficiency* and *value for money considerations* relate to the terms *B* and *C* in the model. Relative efficiency between the traditional paths of procurement and PPP simply refers to differences in *C,* holding *B* constant. Similarly, value for money considerations between the traditional paths of procurement and PPP refer to the differences in the ratio of *B* over *C*. The third theme, the *cost of capital* concern refers to differences in discount rate *r*, holding in turn both *B* and *C* constant.

With respect to the contractual relationship in PPP, the associated competitive-negotiated supplier selection protocol, and resulting performance-based contract types do not require that the contractor's efforts are wholly *specifiable*, *observable* and *verifiable* by the government, and effort is primarily induced through *incentives*. Both the *efficienc*y and *equitability* of a PPP concession were addressed.

First, the compensation structure of the concession is efficient, because it aligns the interests of the project company and the society. The concessionaire has every incentive to contribute to the performance of the asset, because this increases its revenues, but this also improves the value of the service to the government. The contract represents a profit-sharing mechanism, which is incentive-compatible. Therefore, PPP seems to involve lower *agency costs*, because the project is acknowledged to be costly to monitor and effort is primarily induced through *incentives*.

However, the private company has a much higher incentive to exert effort on cost savings than increasing the benefits the asset delivers, because it gains only a fraction of the effort it gives to improving the service; whereas it captures all the *yields* from cost saving efforts – the government "profit" is independent of the costs. The concession ensures efficiency, but unless the revenue mechanism is tied to the private costs, the contract favors the project company, and equitability is not secured in the long-run.

Within the limits of the model developed it also possible to infer that the private company assumes all *production risks* related to general macroeconomic conditions and input and prices unique to the particular infrastructure asset, or more accurately, the financiers of the private company assume the risks, which is reasonable, given that they are also entitled to all the surplus yields from cost savings. More risk is generally acceptable with a higher expected return. In the traditional path of procurement, taxpayers, who effectively provide the funds as well as credit insurance to the sovereign state, are not remunerated for the risks they assume.

7.2 Cost of Private Finance Relative to Total Cost of Public Finance

A conventional argument, typically favored by politicians, has been that a government should fund infrastructure development, because it can borrow capital at a low interest rate. However appealing the practice seems at first thought, it is based on an incomplete or even erroneous understanding of economic theory and the framework of financial markets in both theory and practice.

This study showed that when a government allocates funds borrowed at a risk-free rate to an inherently risky venture, the government violates the principles of financial markets, by allocating capital at a risk-free rate to an inherently risky project, and incurring an opportunity cost thereby. The government effectively subsidizes a public producer with an amount equal to the implicit costs, included in the opportunity cost in addition to the explicit costs of debt service.

Most importantly, the government does not consider the implicit costs, which are a basic, but fundamental concept in economic theory. Given that the government has access to cheap capital it could have chosen to use the resources by investing in an efficient portfolio of assets, which provide an expected rate of return higher than the risk-free rate. By choosing to forego this opportunity, the government in fact loses a lucrative opportunity to make an investment profit.

To review, opportunity cost is the value of the best alternative use of resources, in this case pure capital. One course of action the government could follow instead of investing itself in the infrastructure project is pure financial investment. The government, in essence, would function like any bank, taking in funds amounting to D, for which it pays an interest rate r_f, denoted by *(1)*, and subsequently investing these resources $I = D$ in an efficient portfolio of assets that generate an expected rate of return $r_p > r_f$. The government would thus be expecting revenues of $R = I(r_p)$ each year, debt service costs of $I(r_f)$ each year, and making an expected investment profit of $\pi_i = I(r_p - r_f)$ each year.

The government, in considering functioning like a bank, should be willing to invest in the project if it is offered the same rate of return r_d that other debt investors expect from this venture, considering all the risks inherent in the project projections. Therefore, the government should be indifferent between investing in some other portfolio of assets and investing in the project, if $r_p = r_d$.[139] This is essentially equal to the government investing in the project at a fair cost of capital. And *the periodic opportunity cost* of investing itself in the project, and not in a portfolio of assets, *is equal to the revenue foregone*, $OC = I(r_d)$. Moreover, the total OC over the life of the project is the cumulative total of periodic opportunity costs $I(r_d)^T$.

The government, by investing itself in the project, thus foregoes the opportunity of receiving revenues of $I(r_d)$. Its periodic explicit debt service costs are, given an excellent credit rating, still defined by the risk-free rate

[139] The rate r_d is essentially also the rate at which the private supplier can raise capital.

r_f of borrowing, and amount to only $I(r_f)$. However, the opportunity cost calculated includes both the explicit and implicit costs, and therefore the periodic implicit costs of investing in the infrastructure project are defined by $I(r_d) – I(r_f) = I(r_d – r_f)$, where $r_d > r_f$, because *the project is inherently risky*. The total implicit costs of the government investing in the project are thus defined by $I(r_d – r_f)^T$, *and are essentially equal to the customary conception of differences in private and public sector cost of capital.*

> *These implicit, economic costs are typically ignored in PPP analysis, and explain – moreover quantifies – the apparent, but erroneous cheapness of sovereign funding.*

What happens from the perspective of the private party is that the government intervenes in the construction market and favors the public party by supplying it with unnaturally cheap capital, which in the case of a capital-intensive infrastructure project represents a key production factor and a decisive competitive advantage, and equal to the government's implicit costs, $I(r_d – r_f)^T$. This is nothing else than a form of subvention, which, in fact, is prohibited by competitive legislation.

Economic theory attests that it is beneficial for a social planner, i.e. the government, to ensure that certain public goods such as highways are provided, but economic theory also promotes fair competition and that for any given purpose the most efficient means are chosen. There is no reason why a government should favor a public party over a private party when alternatives are available, and the government is effectively violating sound economic principles captured in legislation as well. The government could, in principle, borrow on its general credit and leak the funds at the same cost of capital to the private party, which would ensure a fair competitive setting.

To illustrate the rationale of the result further, the implications of a counter-assumption were explored. More specifically, an extreme example of financing *all* economic activity on a general government rating was used. Should this occur, the international financial markets would

eventually realize the actual risk inherent in the governments deteriorating loan portfolio, which would obviously include some very risky ventures (stimulated, partly, by cheap capital), lower the general credit rating of the nation as a consequence, and thereby correct the pricing of capital inevitably. Thus, by the logic of induction, because the practice is undesirable if extended indefinitely, it follows that the practice must be undesirable for a singular case too.

By confusing its role as a social planner and a producer unit, the government distorts the functioning of markets. A public option may not be economically the most low-cost alternative, but it is nevertheless chosen when low-cost capital offsets higher production costs. A government cannot, by borrowing and investing itself in the project benefit the domestic economy, because it could achieve the same effect by adopting the role of a pure investor and letting the project company raise funds at a fair cost of capital. Therefore, to evaluate a public and private led production on a level fair basis, the government should, itself, finance on a project basis, or allow the private party access to the low-cost funds available on the government's credit rating. However, even this approach would fail to account for differences in transaction costs between a PPP and a traditional government led approach.

7.3 Comparative Economic Efficiency of Public-Private Partnership

Since the cost of capital is not a valid criterion for evaluating the traditional, government funded paths of procurement and the privately funded PPP, the analysis focused on the underlying production and transaction cost economics of the two alternative approaches in the organization of the production of infrastructure goods.

The analysis omitted costs of externalities to focus on the differences between private (production) and transaction costs. The analysis of private and transaction costs corresponds to the key theme of *relative efficiency* that has emerged in the literature on PPPs. The concern is whether it makes sense to organize the production of infrastructure assets and service through a PPP. In other words, whether or not a PPP can produce the same

societal benefits at a lower cost relative to the traditional approach? Ultimately, this question can be answered only through empirical research; but the study addressed the question based on a theoretically well-founded framework and logical reasoning, and produced explanatory propositions in result.

The study focused on the implications of increasing the physical scale and scope as well as the temporal duration of transport infrastructure projects. It seems there are better opportunities to exploit economies of scale and scope as well as to invest in specialized capital that yield long-run cost savings in PPP. However, the main point predicted by the theory of industrial organization is that these cost savings are inevitably offset to some extent by an increase in the transaction costs associated with writing contracts under progressively more difficult circumstances, i.e. with more sizeable projects and longer-run contracts. Another problem with sizeable projects and long-run contracts is also that due to cognitive constraints and unforeseeable events, it may be impossible or highly costly to design contracts that account for all contingencies. However, for the purpose of maintaining clarity and simplifying the analysis, complexity and uncertainty were held constant. The table (Table 4) below summarizes the propositions and the key justifications for each proposition:

Table 4 Summary of the propositions on the comparative economic efficiency of PPP predicted by theory

Proposition	Justification
The comparative unit production costs of PPP are negatively related to the physical scale and scope of the project	PPP reduces comparative unit production costs due to higher economies of scale and scope associated with a more sizeable deliverable
The comparative unit production costs of PPP are negatively related to the temporal duration of the project	PPP reduces comparative unit production costs due to higher (front-end) potential to invest in specialized physical and human capital
The comparative transaction costs of PPP are negatively related to the physical scale and scope, and the temporal duration of the project	PPP makes proper use of incomplete contracts, positive incentive and dedicated neutral arbitration mechanisms under persistent information asymmetry; whereas the traditional paths of contracting fail to account for the persistent information asymmetry related to infrastructure goods
There exists a point in the increasing direction of the size and duration of a project at which PPP becomes comparatively efficient	The benefits of a reduction in unit production costs of PPP outweigh the associated increase in transaction costs, which is an assertion also supported by empirical evidence
Government captures a comparatively smaller share of the higher surplus associated with a PPP scheme	PPP is associated with the dynamics of a competitive-negotiated procedure and the use of variable, profit-sharing compensation

Nonetheless, the point is that, in principle, an increase in the transaction costs associated with a more sizeable and longer project is unavoidable. However, the common motive of minimizing costs still applies, and there

are alternative contracting paths that can be followed to minimize transaction costs under progressively more difficult circumstances.

PPP, from a total welfare perspective is efficient, when the benefits gained from technological synergies related to a more sizeable project deliverable as well as the opportunities to invest in dedicated, specialized capital and the consequent long-run yields *offset* the higher explicit costs of contracting. Assuming so, the resulting surplus is also divided more equitably between the government and the supplier. In other words, the private supplier captures a proportionally greater share of the surplus implied by infrastructure production than in the traditional approach. In reverse, the government surplus is proportionally lower, even if it is higher in absolute terms due to more efficient production and transaction cost economics.

As already noted, the analysis did not incorporate comparative changes resulting from increasing uncertainty and complexity. It, however, seems warranted to argue that when a project is of a highly complex and uncertain nature, it is ill-suited for a PPP arrangement. For example, it is difficult to enact a proper payment structure if the value of the output is difficult to assess, that is, when quality plays a significant role in contrast to quantity, making monitoring very costly, if not impossible.

In services such as hospital care, where the experience of the patients is strongly affected by the empathy, discreteness and other intangible qualities of the personnel and where many unique, unforeseeable events may arise, PPP is hardly viable. It would be extremely difficult to specify all contingencies, let alone monitor the intangible qualities of the service. In road networks, in contrast, where complexity and uncertainty are relatively low, PPP seems more viable. This view is consistent with world-wide empirical evidence and, in fact, gives an explanation of why PPP projects are first launched in markets with mature, tangible goods, where complexity and uncertainty are relatively low.

8 DISCUSSION

In this chapter the outcomes of the study are discussed. The chapter is organized into four sections. In the first two sections, the results of the study are reflected against prior research and evaluated by their practical relevance and theoretical contribution. Basically, there are implications that result from each of the results corresponding to the three, largely self-standing research questions. Some implications of the results for practitioners involved in PPP projects as well as scholars focusing on the subjects are explored. The third section discusses the reliability and the domain of validity of the study, and the final one suggests some attractive avenues for further research.

8.1 Practical Relevance of the Study

First, the inquiry into the underlying economics of the production of transport infrastructure assets and services yielded a number of profound insights into PPP. The rationale for the joint participation of the public and private sectors can be reduced to concept of externalities, and subsequent market dysfunction that makes centralized government intervention in decentralized markets necessary. The contracting difficulties typical in the construction industry, and project business at large, can be reduced to the concept of experience goods, whose quality and cost characteristics are difficult to ascertain prior to purchase and only come evident as the good is used over a long-term period.

Foremost, the concept signifies the idea that the information asymmetry between the government and the supplier is not fully resolved at the time of contracting, or the point of construction completion, or not necessarily even within the standard warranty period. This in turn, has major implications on the design of contract mechanisms in the construction industry at large. Very roughly, under information asymmetry, lump-sum or fixed cost-plus structures do not induce optimal effort in part of the supplier and are therefore inefficient contractual mechanisms.

Second, the economical model developed can be used to evaluate the viability of PPP projects from a total social welfare viewpoint, and the perspectives of the government (client) and the concessionaire (the supplier). The model can also be considered a contribution on its own as it embodies the underlying characteristics of PPP, namely multiple parties, key cash flows, uncertainties, private costs and revenues, social externalities and social pricing. The robustness of the model is supported by the subsequent chapters, where the model served well as a basis for analyzing the key recurrent concerns related to PPP.

Third, the result that sovereign finance is not cheaper than private finance, when both implicit and explicit costs are considered, suggests that the cost-efficiency of the PPP is substantially higher than is customarily assumed. This can be considered as a highly important result with profound implications in practice. In brief, researchers, government officials, and even potential project consortia should take this fact into account in developing further PPP schemes. The figures that were developed, on basis of the earlier model, serve to tie the argumentation into a more easily comprehendible form and to facilitate communication.

Fourth, a theoretical analysis shows that incorporating traditionally segmented, fixed-fee, short-term contracts under a single, long-term performance-based concession provides opportunities for technological synergies, investment in specialized capital and contract mechanisms that minimize production costs relative to traditional procurement resulting in higher net surplus from a total social welfare perspective, given that the associated transaction costs increase proportionally less. The five propositions developed in the study represent theoretically well-founded causalities, which contribute to a fundamental understanding of the economic phenomenon that has come to be denoted as PPP.

The consideration of the implicit costs of capital, and the propositions on the comparative efficiency of PPP presented, predict that we can expect to see significant growth in the PPP market if these results are accepted and once political inertia is surmounted. Based on well-founded economic

theory, PPP does, indeed, seem more cost-efficient than traditional, public procurement paths for producing infrastructure assets and services.

The viability of PPP thus endangers officials in government agencies that are subject to downsizing if more transport sector activities are conferred to PPP arrangements. We can also predict resistance from government officials who confuse their role as a social planner (a representative and advocate of the total interests of the economy), with their role as a representative of a local government profit maximizing unit. The market also appears attractive to construction companies, who could take this into account in their strategic positioning considerations. An increase in PPP activity and consequent cost-efficiency should also have a positive effect on social welfare and citizen-consumers, whose tax liabilities could, to some degree, be anticipated to be relieved.

8.2 Theoretical Contribution of the Study

First, the conception in the field of construction economy that a PPP project is simply one alternative among nearly infinitely many project delivery alternatives, obscures the fact that financing on a project-basis involves an altogether different form of organization: an independent economic unit with a finite life. The economic and financial approach adopted in this study shows that PPPs represent a fundamentally different alternative mode of project delivery and should not be regarded as a mere variation of traditional project delivery.

This seems to be an important result, because it directs attention to the multiple necessary conditions and consequential implications that follow from having a separate legal entity, capable of functioning economically on a stand-alone basis, and subjected to the discipline of capital markets. Based on this conception, the model of PPP developed in this study is a broad enough approximation to be valid, but narrow enough to focus the study on only the critical aspects of PPP. There are multiple representations of PPP in literature; however, they are typically directed at a non-academic audience and do not capture the basic requirements for an economic model of PPP.

The basic problem of the research approach adopted by some scholars is that they seem to fail to reduce the study of the complexities of PPP to the underlying economic fundamentals; moreover, they sometimes do not even seem to attempt to relate their studies to scientific discourse.[140] Although this approach does not conform to the basic principles of science, it could be argued that these are liberties, which an established scholar can assume. Nevertheless, the consequence is that the validity of such studies is inevitably undermined (on the other hand, the conflict of such results with world-wide trends is explained).

Another important contribution to project management literature can be drawn from the analysis of the traditional lump-sum and cost-plus contracts based on the principal-agent framework. The basic point is that project management literature views lump-sum and cost-plus contracts as the polar extremes of contractual options, and positions performance-based contracts somewhere in the intermediate region of these two. From the viewpoint of principal-agent theory this is a conceptual confusion. Lump-sum and cost-plus contracts are essentially *fixed* compensation structures that rely on complete specifications and do not vary with the performance of the contractor. In essence, they do not encourage optimal effort, when effort costly or impossible to observe. Theory posits that under such conditions, i.e. information asymmetry, effort must be *induced* by performance-based *variable* compensation schemes, which are fundamentally different from fixed wages, and should therefore not be positioned in between, so as to avoid obscuring the key distinction.

Second, the study has shown, based on basic investment theory and standard logical induction, that arguments against PPPs, which are based on the lower cost of borrowing on a government's general credit, typically favored by politicians, are incomplete. Economic theory does insist that it is beneficial for a government to intervene and ensure certain economic activity, but in comparing alternative arrangements to organize this

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[140] See e.g. Kiiras et al. 2005

activity, a government led alternative should not be favored by evaluating it with an unfair cost of capital. The theoretical analysis therefore does not show that the procurement and delivery of major public infrastructure, such as highways, through a PPP arrangement is inferior or superior to traditional forms of procurement, but only that arguments relying on the cost of borrowing are incomplete and may lead to undesirable action

While there is some support in academic literature for arguments that insist public government finance is preferable, because of ability to borrow at risk-free rate of interest or better ability to diversify investment risk, the result of this study is consistent with current theoretical orthodoxy, which suggests that the cost of capital of the public sector is not below that of the private sector.[141]

The contribution of this study is that it *takes this result further by providing a specific interpretation of what happens when a government allocates funds borrowed at a risk-free rate to an inherently risky venture.* The consequence is that the government violates the principles of financial markets, incurring an opportunity cost and subsidizing a certain economic activity with an amount equal to the implicit costs included in the opportunity cost. The controversy, in fact, *dissolves*, once PPP is subjected to a robust economic analysis that takes into account all costs, both implicit and explicit. This result substantiates the challenge to public finance contended by Klein:[142]

> *"The apparent cheapness of sovereign funds reflects the fact that taxpayers, who effectively provide credit insurance to the sovereign state, are not remunerated for the contingent liability they assume. If they were to be remunerated properly, then the advantage of sovereign finance would – almost by definition – disappear."*

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[141] Flemming & Mayer 1997; Klein 1997
[142] Klein 1997

The results of this analysis are something that scholars in, e.g. the field of construction economics have failed to see. They have consistently insisted on the practically appealing practice of borrowing on a government credit to fund infrastructure development, which, in fact, may violate the economic principles of market economy and even prevailing legislation. Consequently, their calculations are theoretically inconsistent and the results thereby gained invalid. A low-level project *procurement*, or vice versa, *delivery* approach should be replaced with a higher-level *economic* approach, that searches for the cost-minimizing form of organizing the production of infrastructure goods and services within an economy.

Third, regarding the comparative efficiency of PPP relative to traditional paths of procurement, the nine propositions derived in this study build on general economic concepts, in other words a theoretically sound foundation. The propositions stand in profound contrast to hypothetical calculations that require multiple assumptions, and, as anyone familiar with modeling knows, can easily be "tweaked" to serve any arbitrary interests, although this is certainly not necessarily the case.

Although all of the propositions presented in this study are in conflict with some research,[143] they are consistent with a number of theoretical findings. For example, many authors have argued that principal-agent problems are likely to be lower in the private than in the public sector. Brealy et al.,[144] for instance argue that *"the private sector appears to be better than the public sector in handling agency problems. It can consequently produce more efficiently."* According to Currie,[145] principal-agent relations are more complex in the public sector; whereas the presence of the profit motive incentivises good performance in the private sector, helping to align the goals of the principal and the agent, and thereby mitigate transaction costs.

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[143] Kiiras et al. 2005
[144] Brealy, Cooper & Habib 1997
[145] Currie 2000

Most importantly, the theoretical results are consistent with practice, where PPP activity has significantly increased world-wide and the experiences have been highly positive. In Finland, political pressure to increase efficiency, and increasing pressure from the private sector, has led to the incremental development of arrangements that are aimed at correcting the confusion between the role of the government as a social planner and the role of producer units. New arrangements are being adopted in Finland, more widely e.g. in Rovaniemi county sector under the term Client-Contractor model (Tilaaja-Tuottaja malli) and more narrowly in the road sector, by the name PPP (Elinkaarimalli). The development is controversial, partly since the interests of government bureaucrats are divergent: the new arrangements typically lead to restructuring, or more plainly, down-sizing of the public sector organizations.

8.3 Reliability and Validity of the Study

8.3.1 Reliability

Reliability is a concept scientifically associated with statistical analysis, and is concerned with the possibility and quantity of error in the use of statistical methods. In a study based on inductive reasoning and case study such as this, reliability is primarily concerned with the replicability of the results, i.e. would another researcher arrive at the same results? The reliability of the results therefore relies on the objectivity and logical consistency of the research.

In this study two primary measures were taken to ensure objectivity and logical consistency. First, the study is grounded in basic, theoretically well-founded conceptual frameworks that served as the basis for guiding attention, articulating arguments and organizing analysis. Second, the line of thinking has been made explicit as far as possible within the limits of a written report. Most of the conceptual results gained are consistent with empirical evidence, which could be interpreted as a signal of reliability. Generally speaking, the reliability of the study is deemed high. Nevertheless, it is up to the audience to decide whether the reasoning is explicit, critical and unbiased.

8.3.2 Validity

Validity is a concept again primarily associated with statistical analysis, and is concerned with the congruence between the concepts used and the data obtained through measurements. Validity of a study refers to an accurate operationalization of the conceptual framework into measurable variables. In a study based on inductive reasoning and case study such as this, validity is primarily concerned with the consistency of the theoretical framework, the discipline of the research procedure and the domain to which the results can reasonably be generalized.

First, it seems that the primary theories employed, industrial organization and investment theory are consistent, since they all draw from the same background: economics. Investment theory is often characterized as applied economics, and industrial organization is a branch of microeconomics that conforms to the ideas of optimizing behavior and motive for cost-minimization. In fact, they are both based on the paradigm of rational decision making, applied to industrial markets and financial markets, respectively. The study intentionally chose to rely on the explicit conceptual frameworks of basic theories so as to avoid an intellectual exercise that is systematic and resembles science, but is in effect intellectual nonsense.

It can be argued that the paradigm of rational decision making is not a valid description of the actual behavior of people in firms and markets. Yet, it would make no sense to dismiss the paradigm as useless, since conceptual analysis always relies on approximations of reality, and rational decision making provides a particularly weathered, and conceptually consistent framework. Any conceptual framework always falls short of the complexities of reality, but at least the abstraction used is explicit and analytically and not merely intuitively appealing. The framework provides a strong foundation, whose assumptions can be relaxed to study deviations that are not explained by the framework as such.

The discipline of the research procedure has been attempted to make visible by writing out the lines of thinking explicitly throughout this report,

and is, therefore, deemed high. The study arrived at three substantial results, which, as long as the study is reliable, are valid within the settings of Finnish PPP industry and financial markets.

One weakness of the study is that ultimately, the results need to be validated through empirical research. The overarching research tradition that this study belongs to values empirical evidence, but concerning the novelty of the subject and the surrounding conceptual confusion, it seemed justified and foremost necessary to adopt a rather theoretical approach to an empirically relevant phenomenon. The topics that were treated in the study are highly relevant and a theoretically fertile ground for further study, but a profound investigation was warranted in the first place. In conclusion, it was beyond the scope of this study to subject the models and propositions to empirical analysis, but it seems the theories and reasoning are disciplined enough to suggest a high level of validity.

8.4 Suggestions for Future Research

First, to structure and guide the study PPP in the future, it would be beneficial to make a certain logical distinction. Whether an infrastructure *can* be implemented through a PPP scheme, depends on certain factors, which can be termed as the *necessary conditions.* Whether an infrastructure *should* be implemented through a PPP scheme depends on an additional set of factors, which can be termed as the *sufficient conditions*. The necessary conditions, i.e. to be viable as a PPP, the project must be capable of operating as an economically independent unit (which certainly has fundamental implications). The sufficient conditions, i.e. to be optimal as a PPP, the project must have a higher net present value than a traditional arrangement, all costs, benefits, and risks considered.

Second, the suggested five propositions, which explore the comparative economic efficiency of PPP relative to traditional paths of procurement, could be subjected to empirical analysis, once the Finnish PPP market matures. However, the basic problem with an empirical study of the subject is the difficulty of obtaining data on a phenomenon, which is an on-going process for even more than twenty years. It is also very difficult

to quantify the transaction costs associated with different contractual relationships. It seems intuitively clear and, as this study showed, analytically justified that the contractual practices used in the public sector result in considerable inefficiencies in comparison to private companies. For instance, government officials are typically compensated with fixed wages, where any innovativeness and associated risk taking only have a downside for the individuals concerned.[146]

Nevertheless, the basic purpose of this study was to conceptually clarify some of the key concerns on PPP, and it seems warranted to translate these ideas more concretely to the Finnish context of PPP. The particular question of choosing between procurement alternatives (a "construction management" problem), also translates to a question of choosing between alternative organizational arrangements (a "strategic management" problem), which can be studied as a question of choosing between two alternative courses of investment (an "investment theory" problem), which translates to a question of differences in cash flow patterns (a "managerial accounting" problem), which finally reduces to fundamental economic cost and value factors (an "economic" problem) influenced by economies of scale, scope, management incentives, specialization, etc.

The study has shown that arguments against PPPs, which are based on the lower cost of borrowing on a government's general credit, typically favored by politicians, are incomplete and possibly faulty. Much of public discourse still revolves around this issue, and although relevant, the argument is incomplete and scholars would do well to proceed with a more advanced analysis, which focuses on the underlying economics.

This analysis would relax the assumption that the public and private sector are identical in their capabilities of planning and delivering a service, and could proceed by a systematic analysis of the differences in costs (e.g. overheads, engineering costs, material costs, labor costs and capital expenditure) and societal benefits (e.g. units of usage, units of available

[146] Salmela 2005

capacity, and value of each unit) between a public and private sector project. It could for example, be possible to study differences in the timing of net benefits (e.g. affected by project delays and availability) and the costs (e.g. construction costs, maintenance costs, cost overruns), based on empirical data. With a fair characterization of the net benefits, i.e. free cash flows, and a fair cost of capital, it would be possible to subject public-sector and private-sector led alternatives to an objective investment NPV evaluation.

This comparative evaluation would also serve to evaluate an organizational phenomenon known as hybrids. Specifically, a PPP project is a hybrid arrangement – it involves reliance on the market mechanism in awarding the concession as well as a quasi-vertical organization to administer the exchange. And yes, hybrid arrangements have been proposed to have comparative advantages under certain circumstances – but research has not shown just *how* advantageous. A quantitative comparison of PPP and traditional procurement arrangements would also be a quantitative analysis of alternative organizational arrangements and could be related to this prominent theoretical discourse.

Third, in PPPs the cash flows from the project are paid directly to the project investors, instead of being reinvested by management, which is a rather unique property of the project company setting. Optimal portfolio growth theory has shown that in multi-period investment situations, an investor may actually benefit from the volatility of individual assets, given that there is low correlation between their return, by allowed to pump capital between them during successive periods.[147] Since PPPs return all available cash flows to investors, and thus permits pumping, it could be that this benefits growth seeking investors in the capital markets at large. Although somewhat eclectic, from a social welfare perspective this could be a factor that further promotes the provision of public goods through project-based financing, and worth researching.

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[147] See e.g. Luenberger 1998, Log-Optimal Growth Strategy

Fourth, project finance shares a number of interesting common features with leveraged buy-outs (LBOs), the business of financial entrepreneurs in the industry of private equity. Both LBOs and PPPs are treated as separate economic units; they are both highly leveraged and essentially dependent on the stability of cash flows. It would be interesting and potentially beneficial to explore what lessons could be transferred from one field to another. The potential for research synergies, along with the rapid development of these already significant industries makes this another attractive course of research to follow.

Finally, it would be interesting to direct more attention to the contractual mechanisms used in the construction industry at large, for which the principal-agent framework provides excellent conceptual tools. It seems warranted that compensation schemes in the construction industry were addressed through the concepts of specifiability, observability, verifiability, and adaptation. Moreover, it seems also attractive to study current contract legislation to see how these economic essentials are translated to and represented in jurisprudence. Most importantly, it would be interesting to see how a legal framework, based on the Anglo-Saxon tradition, acknowledges the presence of information asymmetry of experience goods, incomplete contracts and primarily negotiated supplier selection protocols – as an anomaly or a sound, standard practice.

REFERENCES

Arrow, K. 1985. The Economics of Agency. In Principals and Agents: The Structure of Business, ed. Pratt, J. & Zeckhauser, R. Cambridge, Harvard Business School Press.

Artto, K. & Wikström, K. What is Project Business? International Journal of Project Management 23 (5) 343-353.

Bain, J. 1954. Economies of Scale, Concentration and Entry. American Economic Review 44: 15-39.

Berggren, C , Soderlund, J. & Anderson, C. 2001. Clients, Contractors, and Consultants: The Consequences of Organizational Fragmentation. Project Management Journal; Sep 2001; 32, 3; pg. 39.

Bing, L., Akintove, A., Edwards, P. & Hardcastle, C. 2005. The Allocation of Risk in PPP/PFI Construction Projects in the UK. International Journal of Project Management 23(2005) 25–35.

Brealey, R. Cooper, I. & Habib, M. 1997. Investment Appraisal in the Public Sector. Oxford Review of Economic Policy, 13:12-28.

Brickley, J. Lease, R. & Smith, C. 1988. Ownership Structure and Voting on Antitakeover Amendments. Journal of Financial Economics. Vol. 22, 253-278.

Chemmanur, T. & John, K. 1992. Optimal Incorporation, Structure of Debt Contracts, and Limited-Recourse Project Financing. Working Paper FD-92-60, New York University.

Coase, R. 1937. The Nature of the Firm. Economica n.s., 4: 386-405.

Coase, R. 1960. The Problem of Social Cost. Journal of Law and Economics. 3: 1-44.

Cova, B. & Ghauri, P. 1996. Project Marketing: Between Mass Marketing and Networks. The European Seminar on Project Marketing and System Selling, 1996 [Working paper].

Cova, B. Ghauri, P. & Salle, R. 2002. Project Marketing: Beyond Competitive Bidding. Chichester, John Wiley.

Cova, B. & Salle, R. 2004. Project Management and Project Marketing: The Twain Shall Meet. IRNOP VI Conference, Turku, Finland.

Chang, L-M, & Chen, P-H. 2001. BOT Financial Model: Taiwan High Speed rail Case. Journal of Construction Engineering and Management. May/June 2001.Cox. & Townsend. 1997.

Currie, C. The Optimum Regulatory Model for the Next Millenium. In Gup, B. New Financial Architecture for the 21st Century. Greenwood Books.

Davies, P. & Eustice, K. 2005. A Review of PPP Issues and Activity. London, PriceWaterhouseCoopers.

Dealogic ProjectWare. 2005. Search Results from PricewaterhouseCoopers.

Dudkin, G. 2005. Transaction Costs in Public-Private Partnership. Thesis, Helsinki School of Economics.

Eloranta, E. 1981. An Approach for Gross Design of Operations Management Systems. PhD Thesis, Helsinki University of Technology.

Eloranta, E. 1998. Research Method in Industrial Engineering and Management, Lecture. Helsinki University of Technology, 3.10.1998.

Eisenhardt, K. 1989. Building Theories from Case Study Research, Academy of Management Review, 14(4), pp. 532-550.

European Commission. 2003. High Level Group on the Trans-European Transport Network. Van Miert Report.

European Commission. 2004. Green Paper on Public-Private Partnerships and Community Law on Public Contracts and Concessions. COM 327 Final.

Flemming, J. & Mayer, C. 1997. The Assessment of Public Sector Investment. Oxford Review of Economic Policy, 13:1-11.

Finnerty, J. 1996. Project Financing: Asset-Based Financial Engineering. New York, John Wiley & Sons.

Franks, J. 2002. Study into Rates of Return Bid in PFI Projects. London Business School.

Glaser, B. & Strauss, A. 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research, Aldine de Gruyter, New York.

Grossmann, S. & Hart, O. 1986. The Costs and Benefits of Ownership: A Theory of Lateral and Vertical Integration. Journal of Political Economy 94: 691-719.

Hallipelto, A. 2005. Public-Private Partnership. Elinkaarisopimukset ja Vastuu Rakentamisessa – Tuottavuus ja Uudet Toimintamallit Konferenssi [Lifecycle Contracts and Responsibility – Productivity and New Models of Operation Conference] Helsinki, 2.2.2005.

Helsingin Sanomat. 2006. Elinkaarimalli on vain yksi tapa rahoittaa teitä [PPP is Only One Way to Finance Roads]. Pääkirjoitus [Editorial] 29.1.2006.

Howells, P. & Bain, K. 2002. The Economics of Money, Banking and Finance (2nd ed.). London, Prentice Hall.

HM Treasury. 2003. PFI: Meeting the Investment Challenge. July 2003.

HM Treasury. 2004. Value for Money Assessment Guide. London, August 2004.

Jarillo, J. 1988. On Strategic Networks. Strategic Management Journal 9, 31-41.

Jehle, G. & Reny, P. 2000. Advanced Microeconomic Theory (2nd ed.). Boston, Addison Wesley.

Jensen, M. & Meckling, W. 1976. Theory of the Firm: Managerial Behaviour, Agency Costs and Ownership Structure. Journal of Financial Economics. Vol.3, 305-360.

Jensen, M. 1986. Agency Costs of Free Cash Flow, Corporate Finance and Takeovers. American Economic Review. Vol 76, 323-339.

John, T. & John, K. 1991. Optimality of Project Financing: Theory and Empirical Implications in Finance and Accounting. Review of Quantitative Finance and Accounting. Vol. 1, 51-74.

Jick, T. 1979. Mixing Qualitative and Quantitative Methods: Triangulation in Action. Administrative Science Quarterly, vol. 24, no. 4, December, pp. 602-611.

Jokela, P. 2002. Elinkaarimalli - Tiehallinnon Hankintastrategia, Osaraportti [Lifecycle model]. Tiehallinnon Selvityksiä 54/2002. Tiehallinto, Helsinki.

Kaislanlahti, T. 2001. Valtion Omistajaohjaus – Perusta ja Välineet [Government Ownership Control – Basis and Means]. Ministry of Trade and Finance. Helsinki 4/2001.

Kankainen, J. Linholm, M. et al. 2001. Konsessiot Yksityisrahoituksessa sekä Julkisten Hankintojen Sääntely EU:ssa ja Suomessa [Concessions in Private Finance and Public Procurement Provisions in the EU and Finland]. Helsinki, Rakennusteollisuus.

Kauppalehti. 2006. Lohja-Muurla-osuuden Rakentajat Tyrmäävät Väitteet Ylihinnasta [Constructors of Lohja-Muurla Section Defy Arguments of Over Pricing]. Ilkka Sinervä 25.1.2006.

Kiiras, J. 2004. Rakennushankkeet, Niiden Toteutusmuodot ja Riskiominaisuudet [Construction Projects, Their Forms of Implementation and Risk Characteristics]. Opetusmoniste [Course Material], Helsinki University of Technology.

Kiiras, J. Erälahti, J. Maijala, A. Tuhola, M. & Töyrylä, I. 2005. Infrarakentamisen Elinkaaripalvelu: Uusi Elinkaarimalli, Vaihtoehto Elinkaariurakalle [Lifecycle Service for Infrastructure Construction: New Lifecycle Model, Alternative for Lifecycle Project]. Espoo, Helsinki University of Technology.

Klein, M. 1997. The Risk Premium for Evaluating Public Projects. Oxford Review of Economic Policy, 13:29-42.

Koppinen, T. & Lahdenperä, P. 2004a. Road Sector Experiences on Project Delivery Methods. VTT Tiedotteita – Research Notes 2260. Espoo, Finland.

Koppinen, T. & Lahdenperä, P. 2004b. The Current and Future Performance of Road Project Delivery Methods. VTT Tiedotteita – Research Notes 549. Espoo, Finland.

Kumaraswamy, M. & Morris, D. 2002. Build-Operate-Transfer-Type Procurement in Asian Megaprojects. Journal of Construction Engineering and Management. March/April 2002.

Kurkela, M. 2003. Kumppanuussopimukset Elinkaarimallissa: Rakentaminen, Rahoittaminen ja Palvelutuotanto [Partnership Contracts in the Lifecycle Model: Construction, Financing and Service Production]. Jyväskylä, RTK.

Lahdenperä, P. & Rintala, K. 2003. Ajatuksia Elinkaarivastuuhankkeista – Brittiläisten Tilapalveluhankintojen Tarkastelua Uuden Suomalaisen

Käytännön Kehittämiseksi [Thoughts on DBFO. A Study of UK Accommodation Service Procurement for the Benefit of Finnish Practice]. VTT Tiedotteita – Research Notes 2192, Espoo, Finland.

Lam, P. 1999. Build-Operate-Transfer Model for Infrastructure Developments in Asia: Reasons for Successes and Failures. International Journal of Project Management Vol. 17, No. 6, pp. 377-382.

Lam, C. & Chow, W. 1999. The Significance of Financial Risks in BOT Procurement. Building Research & Information (1999) 27(2), 84–95.

Levy, S. 1996. Build, Operate, Transfer: Paving the Way for Tomorrow's Infrastructure. New York, Wiley.

Luenberger, D. 1998. Investment Science. New York, Oxford University Press.

MaCaulay, S. 1963. Non-Contractual Relations of Business Firms. American Sociological Review. 28: 55-70.

Murtoaro, J. Kujala, J. & Artto, K. Negotiations in Project Sales and Delivery Process: An Application of Negotiation Analysis. Espoo, Helsinki University of Technology, Laboratory of Industrial Engineering and Management, Report 2005/3.

Nelson, P. 1970. Information and Consumer Behavior. Journal of Political Economics 78:311-312.

Niiniluoto, I. 1980. Johdatus Tieteenfilosofiaan – Käsitteen ja Teorian Muodostus [Introduction to the Philosophy of Science – Concept and Theory Development]. Helsinki, Otava.

Olkkonen, T. 1993. Johdatus Teollisuustalouden Tutkimustyöhön [An Introduction to Research Work in Industrial Economics]. Espoo, Helsinki University of Technology, Industrial Economics and Industrial Psychology, Report no. 152.

Pakkala, P. 2002. Innovative Project Delivery Methods for Infrastructure – An International Perspective. Finnish Road Enterprise, Helsinki, Finland.

Pietroforte, P. & Miller, J. 2002. Procurement Methods for US infrastructure: Historical Perspectives and Recent Trends. Building Research & Information (2002) 30(6), 425–434.

Perloff, J. 2001. Microeconomics (2nd ed.). Boston, Addison Wesley Longman.

Perrot, J-Y. & Chatelus, G. 1994. Financing of Major Infrastructure and Public Service Projects. French Ministry of Public Works, Transport and Housing.

PricewaterhouseCoopers. 2004. Developing Public Private Partnerships in New Europe. London.

Raiffa, H. Richardson, J. Metcalfe, D. 2002. Negotiation analysis: The Science and Art of Collaborative Decision Making. Cambridge, Harvard University Press.

Rakennusteollisuus. 2002. Elinkaarivastuullinen palveleva rakentaminen [Lifecycle-Responsible Servicing Construction. Helsinki, Libris.

Ranta, J. 1999. Research Methods in Industrial Management – Science, Qualitative and Quantitative Approach In Production Research and Industrial Management. Lecture. Espoo, Helsinki University of Technology, June 1999.

Salmela, V. 2005. Interview at PricewaterhouseCoopers Corporate Finance. Helsinki, 20.10.2005.

Sandalkhan Bakatjan, S. Arikan M. & Tiong, R. 2003. Optimal Capital Structure Model for BOT Power Projects in Turkey. Journal of Construction Engineering and Management. Jan/Feb 2005.

Schaufelberger, J. & Wipadapisut, I. 2003. Alternate Financing Strategies for Build-Operate-Transfer Projects. Journal of Construction Engineering and Management. March/April 2003.

Skaates, M. & Tikkanen, H. 2003. International Project Marketing: an Introduction to the INPM Approach, International Journal of Project Management, 21 ,7, pp. 503-510.

Tam, C. 1999. Financial Commitments of BOT Projects. International Journal of Project Management. 17(6), 377–382.

Tirole, J. 2002. The Theory of Industrial Organization. Boston, Massachusetts Institute of Technology.

Tiong, R. 1995. Competitive Advantage of Equity in BOT Tender. Journal of Construction Engineering and Management. 121(3), 282–289.

Tiong, R. 1996. CSFs in Competitive Tendering and Negotiation Model for BOT Projects. Journal of Construction Engineering and Management. 122(3), 205–211.

Tiong, R. & Alum, J. 1997. Financial Commitments for BOT Projects. International Journal of Project Management. 16(2), 73–78.

Turner, R. & Müller, R. 2003. On The Nature of the Project as a Temporary Organization, International Journal of Project Management, 21, pp. 1-8.

Williamson, O. 1975. Markets and Hierarchies: Analysis and Antitrust Implications.

NewYork, Free Press.

Williamson, O. 1985. The Economic Institutions of Capitalism. NewYork, Free Press.

Williamson, O. 1991. Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. Administrative Science Quarterly 36: 269-296.

Yeoa, K. & Tiong, R. 2000. Positive Management of Differences for Risk Reduction in BOT Projects. International Journal of Project Management 18 (2000) 257-265.

Zhang, X. 2004. Improving Concessionaire Selection Protocols in Public/Private Partnered Infrastructure Projects. Journal of Construction Engineering and Management. Sep/Oct 2005.

Zhang, X. 2005. Critical Success Factors for Public–Private Partnerships in Infrastructure Development. Journal of Construction Engineering and Management. January 2005.