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The role of financial and information constraints in Public and Private Partnerships

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Introduction

Subject of the thesis

This thesis focusses on the use of Public and Private Partnerships (PPPs) for the realization and management of public assets.

"PPPs are way of delivering and funding public services using a capital asset where project risks are shared between the public and private sector. A PPP is defined as a long term agreement between the government and a private partner where the service delivery objectives of the government are aligned with the profit objectives of the private partner. In the PPP, the government specifies the quality and quantity of the service it requires from the private partner. The private partner may be tasked with the design, construction, financing, operation and management of a capital asset and the delivery of a service to the government or to the public using that asset. A key element is the bundling of the construction and operation of the asset. The private partner will receive either a stream of payments from the government, user charges levied directly on the end users, or a combination of both" (OECD, 2013).

From this recent OECD definition, it can be easily realized that the fundamental element of a PPP is the negotiation activity existing between the public and the private parties. This bargaining process can be initially governed by a contract and then, when the formal agreement becomes incomplete, asks for a constructive partnership. In the thesis I study what are the main contractual features and determinants of these investment tools. I face this issue using both theoretical and empirical analyses. In the following paragraphs I first describe the research problem adressed by the Ph.d thesis. Then I outline which is the theory that justifies the presence of PPPs. Finally, I briefly specify the research objectives and I describe the structure of the research project.

Why this thesis?

The global financial and economic crisis has caused a temporary decline in the value of PPP arrangements, in particular in the EU (Wagenvoort et al., 2011). This general trend in transaction volumes and values started in 2010 and has persisted till 2013. The last year has experienced a further reduction in the number of PPP transactions, while the average contract size is significantly increased (around 370 million during the first half of 2013 - EPEC, 2013). The conventional wisdom is that the long-run trend in infrastructure financing and operation across countries features a steady growth of private sector involvement (Wagenvoort et al., 2011).

The current and future relevance of the phenomenon is justified by both the theoretical framework and the the pratical ground that provide relevant reasons to delve deeper into the subject of PPPs. Precisely, what drives the government choice towards the use of PPPs are essentially the possibility to attract private financing and the potential benefit in terms of efficiency improvements. On the other hand, PPPs are defined with the use of long term contracts that are very complex and not able to define every aspect of the investment agreements. As a consequence, the contractual deals turn out to be not enough flexible and not renegotiation proof.

By assessing the pros and cons of PPPs, it is possible to detect which fields are more suitable for their application and whether or not they are able to sustain the growth of a country by improving its infrastructural equipment[1] (Iossa and Russo, 2008). This thesis aims at improving the understanding of PPPs, essentially using the point of view of the public sector. In effect, with the theoretical models I highlight which opportunities public institution can exploit by using PPPs, while with the empirical analysis I study what determines the government's choice in favor of PPPs. Even if public institutions are the ones that are expected to benefit more from the outcomes of this research, important stakeholders are also PPPs practitioners that can understand what governments essentially expect from the private involvement and, as a consequence, which is their best response to the public requirements.

[1]The macroecomic theory sustained by the empirical evidence emphasizes the link between the infrastructural dotation of a country and its performances in terms of growth (both GDP and GDP per capite).

International State of Art

PPPs are contractual agreements that involve more parties with different levels of information for a long term period. In this paragraph I expose which are the theoretical basics of the PPPs literature by focusing on the role of asymmetric information in a multiagent environment.

Traditionally, the agency theory studies how a principal can optimally set a contract to regulate the agent's activity where the last is more informed about his costs and his level of effort. Starting from this insight, there is a considerable literature that has developed the principal agent problem introducing several agents and tasks, both in situations of hidden information and hidden actions.

Most of these papers are based on a moral hazard environment where agents are in charge of multidimensional tasks. Holmstrom and Milgrom (1991) study the optimal assignment of grouping of works to risk adverse agents, concluding that it is optimal to allocate activities according to their measurability characteristics. Itoh (1992) relaxes the assumption of perfect substitutability of tasks in the agent's cost function finding that, when two activities are complements, an additional benefit from the induced cooperation arises[2].

A different problem arises where agents are privately informed about their operating costs and they must be motivated by the principal to truthfully reveal their information. In such a context, Laffont and Martimort (1997) detect the incentive to collude of several agents with private and positively correlated valuations for a public good. Another element characterizing this type of setting is the cost of hierarchy (Gilbert and Riordan, 1995; McAfee and McMillan, 1995). If the regulator has to provide a product made up of complementary components supplied by privately informed agents, the bundled supply allows to avoid an additional component of information cost similar to "the double marginalization problem", this benefit decreases with correlated component costs. Dequiedt and Martimort (2004) extend the previous framework introducing the possibility to use the contractor as an auditor for the subcontractor. They show as the optimal organization exhibits various discrete degrees of consolidation depending on the cost of information sharing; precisely, low monitoring costs and more efficient contractors increase the incentive to consolidate.

[2]This benefit is partially offset with correlated measurement errors due to the opportunity loose of comparative performance evaluations.

Finally, Palfrey (1983) analyses the choice between bundled or unbundled auctions of a multiproduct monopolist facing incomplete information about the preferences of the potential buyers. A large number of bidders increases the seller's preference towards separate auctions determining a gain of efficiency for the society.

Hidden action and hidden information are both considered by the model of Lewis and Sappington (1997). In their setting the agent can deliver a non verifiable cost reducing effort and he can acquire private knowledge about the environment in which he and the principal are operating. They compare two scenarios where these tasks are assigned to a single agent or to two different players. As a conclusion, they detect a preference for task separation that decreases the contracting distortions allowing the principal to create multiple desired incentives simultaneously at a minimun cost. This possibility of acquiring information has been furtherly investigated by several authors. Sobel (1993) studies the principal's preference of dealing with an informed or an uninformed agent, where the latter can receive the information before or after the contract. He shows that the principal always prefers post contractual information. Furthermore, gathering information can be costly, in such a case it's different whether the information can be acquired before signing a contract (Crémer and Khalil, 1992) or before a contract is offered (Crémer et al., 1998). In the first case the principal can deter information acquisition, while in the second situation he must accomodate.

A further aspect that is partially analyzed by the contract theory literature with multiple agents regards the sequentiality of investments. De Fraja (1999) develops a model of incomplete contract framework where the benefit and cost functions of the two players are linked with two-sided direct externalities. He shows that an efficient outcome can be reached when the investment decisions are taken sequentially and the second party that invests is risk neutral. Schmitz (2005) shifts the analysis towards a complete contract framework characterized by risk neutral agents and unobservable effort levels. In his model the probability of making an innovation during the second stage depends on the result of the first phase. This sequential investment can be managed by a single agent or the two phases can be assigned to two different agents. When the project surplus is sufficiently small the principal should choose the first organization, otherwise separation is preferred because it allows to save excessive rents. Finally, Li and Yu (2011) investigates the principal bundling decision during a procurement auction for a sequential project characterized by task externalities. Their work can be interpreted as an extension of Palfrey (1983) in a two stage

sequential games. They conclude that a bundled auction is preferred when the externality between the two phases is positive or when the competitiveness in the market of the joint task is higher with respect to the building (first phase) market.

These strands of literature emphasize several elements that also characterize PPPs procedures, i.e: the presence of multiple agents in a context of asymmetric information, the long term contractual relationship between the principal and the agents, the sequentiality of investments, the existence of externalities among the different phases of the project. Thus, it is worthwhile to develop the previous theories in the applied context of PPPs where all elements occur simultaneously and interact with each other.

Research objectives and structure of the thesis

My research objectives can be summarized in two points:

At first, the thesis aims at improving the theoretical analysis of PPPs by integrating further elements that take mainly into account the presence of uncertain externalities among the phases of a project and the financial aspects of the contractual agreements.

Secondly, I use empirical data to better understand what really affect the use of PPPs and which goals governments aim to attain by choosing these investment tools.

To reach these purposes, the thesis is structured in three chapters that are briefly describe in the following paragraphs.

Chapter 1: Public Private Partnerships: Information Externality in Sequential Investments

This paper studies the benefit coming from bundling two sequential activities in a context of Public Private Partnerships (PPPs). Differently from previous literature, I introduce a source of asymmetric information in the form of an externality parameter linking the building stage with subsequent operational activity.

Within this framework, PPPs allow the government to extract private information about the sign and magnitude of the externality parameter and to to minimize the informational rents needed to incentivize the builder's effort.

Our results suggest how PPPs can become those commitment devices that force governments to define more coherent and informed plans that optimize the first period welfare, improving investment to reduce unexpected ex post costs (cost overruns).

Chapter 2: Public Private Partnerships from budget constraints: Looking for Debt Hiding?

In this paper we examine whether budget constrained public authorities are more likely to use PPP (Public Private Partnership) than tradition procurement. Then, we study the possible mechanisms beyond this choice.

The empirical test focuses on France and consists of a two stage approach. Firstly, we look at the impact of budget constraints on the use of PFI (Project Finance Initiative) and we find a positive relationship. Secondly, to better disentangle the debt hiding effect we exploit the 2011 change in the possibility to underwrite the debt of PPPs.

We find that that debt hiding is a relevant, but not sufficient element for explaining the budget constrained governments' aptitude towards PPPs.

Chapter 3: Public and Private Finance of PPPs

This theoretical paper studies the effect of public and private budget constraints on the government's choice between Public Private Partnerships (PPPs) and Traditional Procurement (TP) mechanisms. Differently from the previous literature, I introduce private limited liability and public budget constraints in a context characterized by asymmetric information. In this framework, private agents are protected in case of bad outcomes from the probability of failure. Furthermore, public transfers are socially costly for the government.

Under PPPs, the private consortium, thanks to its long term commitment in the project, owns an implicit incentive to invest during the building stage. As a conse-

quence, the agent can accept higher levels of risks and the the government can save money in the form of incentive rents.

This paper provides a theoretical explanation for the empirical evidence which shows how budget constrained governments are more apt to choose PPPs (Hammami et al., 2006; Albalate et al., 2012; Russo and Zampino, 2010; Krumm and Mause, 2012; Buso et al., 2013). The result is not derived from the presence of private financing, but it comes from the introduction of asymmetric information in conditions of financial stress.

Introduzione

Oggetto della tesi

La tesi sviluppa il tema del Partenariato Pubblico Privato (PPP) nell'ambito della realizzazione di infrastrutture e opere pubbliche. Tali strumenti di investimento sono stati definiti nel seguente modo dall'OCSE (Organizzazione per la Cooperazione e lo Sviluppo Economico):

"Il PPP rappresenta una modalità per fornire e finanziare servizi pubblici utilizzando un capitale nel quale i rischi del progetto siano condivisi tra il settore pubblico e privato. Il PPP è definito come un accordo a lungo termine tra il governo e un partner privato in cui gli obiettivi del governo di erogazione dei servizi siano allineati con gli obiettivi del partner privato di realizzazione di un profitto. Nel PPP, il governo specifica la qualità e la quantità del servizio. Al partner privato possono essere assegnate le fasi di progettazione, costruzione, finanziamento, gestione. Un elemento chiave è l'accorpamento delle fasi di costruzione e gestione del bene. Il partner privato può ricevere come corrispettivo: un flusso di pagamenti da parte del governo, delle tariffe d'utenza direttamente dagli utilizzatori finali, o una combinazione delle due modalità" (OCSE, 2013).

Da questa recente definizione dell'OCSE, si può facilmente intuire come l'elemento fondamentale di un PPP sia il rapporto a lungo termine tra la sfera pubblica e privata. Il processo di negoziazione può essere inizialmente regolato attraverso un contratto. Successivamente, quando l'accordo formale si rivela inadeguato, vi è necessità di un più forte rapporto di collaborazione informale. In questa tesi vengono analizzate le principali caratteristiche contrattuali e le motivazioni istituzionali riguardanti l'utilizzo e la scelta di questi strumenti di investimento. Lo studio è sviluppato attraverso analisi teoriche ed empiriche. Nei paragrafi successivi viene inizialmente descritta la principale motivazione di ricerca della tesi di dottorato. Successivamente, viene presentata la teoria economica che giustifica la presenza dei

PPP. Infine, vengono specificati brevemente gli obiettivi di ricerca e viene descritta la struttura della tesi.

Perchè una tesi sui PPP?

La crisi finanziaria ed economica ha causato una temporanea riduzione del valore dei PPP, in particolare all'interno dell'UE (Wagenvoort et al., 2011). Questo trend riguardante i volumi e il valore delle transazioni è iniziato nel 2010 e si è protratto fino al 2013. L'ultimo anno ha registrato una ulteriore riduzione per quanto concerne il numero di operazioni eseguite tramite PPP, mentre la dimensione media dei contratti è aumentata significativamente (circa 370 milioni nel primo semestre del 2013 - EPEC, 2013). Per quanto riguarda ill lungo periodo si prospetta un crescente coinvolgimento del settore privato nel finanziamento delle infrastrutture e delle opere pubbliche (Wagenvoort et al., 2011).

La rilevanza attuale e futura del fenomeno è giustificata sia dal quadro teorico che dal contesto applicato che forniscono motivi rilevanti per approfondire maggiormente il tema. Precisamente, la scelta del governo a favore dei PPP consente di attrarre finanziamenti privati e può generare miglioramenti in termini di efficienza. D'altra parte, i PPP sono definiti tramite contratti a lungo termine che sono molto complessi e non in grado di definire preventivamente ogni aspetto dell'accordo di investimento. Di conseguenza, le offerte contrattuali risultano, il più delle volte, non sufficientemente flessibili e oggetto di facile rinegoziazione.

Valutando i pro e i contro dei PPP, è possibile rilevare i settori maggiormente adatti alla loro applicazione e la loro reale capacità di incrementare la dotazione infrastrutturale di un paese generando, in tal modo, un effetto positivo in termini di crescita economica[3] (Iossa and Russo, 2008). Questa tesi mira a migliorare la comprensione dei PPP, l'analisi viene sviluppata utilizzando, essenzialmente, il punto di vista del settore pubblico. In effetti, con i modelli teorici, vengono sottolineate le opportunità per l'ente pubblico derivanti dall'utilizzo dei PPP. L'analisi empirica evidenzia, invece, i principali fattori in grado di orientare la scelta del governo verso i PPP.

[3]La teoria macroecomica sostenuta dall'evidenza empirica sottolinea il legame tra la dotazione infrastrutturale di un paese e le sue prestazioni in termini di crescita (sia del PIL che del PIL pro capite).

Nonostante i risultati di questo progetto di ricerca siano rivolti essenzialmente a favore dei soggetti operanti nella sfera pubblica, anche gli attori privati operanti nel mercato dei PPP possono usfruire di questo lavoro per comprendere maggiormente ciò che i governi si aspettino dal coinvolgimento privato e, di conseguenza, quale sia la risposta ottima in grado di massimizzare i loro profitti soddisfando le esigenze governative.

Principi teorici

I PPP sono accordi contrattuali che coinvolgono più parti con diversi livelli di informazioni per un lungo periodo. In questo paragrafo verranno esposti i fondamenti teorici alla letteratura dei PPP focalizzando l'attenzione sul ruolo dell'assimetria informativa in un ambiente multiagente.

Tradizionalmente, la teoria dei contratti applicata ad un contesto principale-agente studia come un principale può scrivere in modo ottimale un contratto per regolare l'attività di un agente che risulta maggiormente informato sui propri costi di produzione e sul proprio livello di sforzo. Partendo da questa impostazione, la letteratura ha sviluppato il problema introducendo diversi agenti e diverze attività, e considerando la presenza sia di informazioni private che di azioni non osservabili.

La maggior parte di questi lavori di ricerca sono sviluppati in un contesto caratterizzato da "azzardo morale". Holmstrom e Milgrom (1991) studiano l'assegnazione di gruppi di attività ad agenti avversi al rischio, stabilendo come ottimale l'allocazione degli incarichi in base alle caratteristiche e alle possibilità di misurabilità. Itoh (1992) rilassa l'ipotesi di perfetta sostituibilità fra mansioni diverse, constatando l'esistenza di un ulteriore vantaggio cooperativo in presenza di attività complementari.

Un diverso problema sorge quando gli agenti sono privatamente informati sui loro costi di funzionamento e devono quindi essere motivati dal principale a rivelare correttamente le proprie informazioni. In tale contesto, Laffont e Martimort (1997) constatano come diversi agenti con valutazioni private e correlate positivamente per un singolo bene pubblico siano incentivati a colludere tra loro. Un altro elemento che caratterizza questo tipo di approccio è il costo della gerarchia (Gilbert e Riordan, 1995; McAfee e McMillan, 1995). Se il regolatore deve fornire un prodotto costituito

da componenti complementari forniti da differenti agenzie con informazione privata, il consolidamento dell'offerta consente di evitare un ulteriore componente di costo informativo simile al "double marginalization problem" che si osserva in caso di doppio monopolio.

Azioni non osservabili e informazioni private sono entrambe prese in considerazione da Lewis e Sappington (1997). Nel loro modello l'agente può, attraverso un maggior livello di sforzo non osservabile, ridurre i costi del progetto. Inoltre, è possibile acquisire informazioni private riguardanti l'ambiente operativo. L'analisi confronta due scenari: nel primo caso le mansioni sono assegnate ad un singolo agente; nel secondo caso due soggetti privati si prendono carico di due attività differenti. In conclusione, l'analisi rileva una preferenza nei confronti della divisione dei compiti che consente di diminuire le distorsioni amministrative permettendo al principale di creare più incentivi ad un minimo costo.

Un ulteriore aspetto che è parzialmente analizzato dalla letteratura principale-agente riguarda la sequenzialità degli investimenti. De Fraja (1999) sviluppa un modello con contratti incompleti nel quale i costi e i benefici del principale e dell'agente sono collegati attraverso esternalità reciproche. Lo studio mostra come un risultato efficiente può essere raggiunto nel caso in cui le decisioni di investimento siano prese sequenzialmente e il secondo investitore sia neutrale al rischio. Schmitz (2005) propone un modello con contratti completi, agenti neutrali al rischio e livelli di sforzo non osservabili. Inoltre, la probabilità di innovare durante la seconda fase progettuale è strettamente legata al risultato della prima fase. Tale investimento sequenziale può essere gestito da un singolo agente o le due fasi possono essere assegnate a due diversi agenti. Se il surplus del progetto non è eccessivamente elevato, la soluzione con un agente è ottimale, altrimenti la divisione delle mansioni è preferibile in quanto consente un risparmio sulle rendite informative.

Questi filoni di letteratura sottolineano alcuni elementi che caratterizzano anche le procedure di PPP, cioè: la presenza di più agenti in un contesto di informazione asimmetrica, il rapporto contrattuale a lungo termine tra il principale e gli agenti, la sequenzialità degli investimenti, l'esistenza di esternalità tra le diverse fasi del progetto. Partendo dalle teorie precedenti è quindi possibile sviluppare in maniera più appofondita il contesto teorico dei PPP nel quale tutti gli elementi precedenti menzionati si verificano simultaneamente e interagiscono tra loro.

Obiettivi di ricerca e Struttura della tesi

I miei obiettivi di ricerca possono essere riassunti in due punti.

In un primo momento, la tesi mira a migliorare l'analisi teorica sui PPP, integrando ulteriori elementi che tengano maggiormente in considerazione: la presenza di esternalità informative tra le fasi di un progetto e gli aspetti finanziari degli accordi contrattuali.

In secondo luogo, viene utilizzata l'analisi empirica per comprendere le determinanti dei PPP e gli obiettivi perseguiti dai governi attraverso tali strumenti di investimento.

Per raggiungere tali obiettivi, la tesi è strutturata in tre capitoli che verranno descritti brevemente nei paragrafi seguenti.

Capitolo 1: Public Private Partnerships: Information Externality in Sequential Investments

Questo lavoro di ricerca studia il beneficio proveniente dall'affidamento di due attività sequenziali ad un singolo agente in un contesto di PPP. Diversamente dalla letteratura precedente, l'analisi prevede la presenza di informazione asimmetrica nella forma di un parametro di esternalità che collega la fase di costruzione con la successiva attività operativa.

In tale contesto, i PPP permettono al governo di estrarre l'informazione privata riguardante il parametro di esternalità e ridurre al minimo le rendite informative necessarie per incentivare l'attività del costruttore.

I risultati suggeriscono come i PPP possano diventare quei dispositivi che costringono i governi a definire piani più coerenti e consapevoli in grado di ottimizzare il benessere della popolazione minimizzando i costi operativi non previsti (sforamento dei costi).

Capitolo 2: Public Private Partnerships from budget constraints: Looking for Debt Hiding?

In questo articolo viene esaminato il ruolo dei vincoli di bilancio pubblici nella propensione a utilizzare i PPP rispetto agli appalti tradizionali. Successivamente, vengono esaminati i possibili canali di trasmissione in grado di spiegare l'effetto trovato.

L'analisi empirica è sviluppata nel contesto Francese e consiste in un approccio a due fasi. In primo luogo, viene studiato l'impatto dei vincoli di bilancio sull'uso dei contratti PFI (Project Finance Initiative) e i risultati evidenziano un effetto positivo. In secondo luogo, per escludere la possibilità che tale impatto sia esclusivamente spiegato da vantaggi contabili, viene utilizzato un cambiamento legislativo introdotto nel 2011.

L'analisi evidenzia come, nonostante i vantaggi contabili siano rilevanti nello spiegare l'effetto delle restrizioni di bilancio, essi non sono sufficienti a chiarire la propensione a favore dei PPP di istituzioni con maggiori vincoli e difficoltà finanziarie.

Capitolo 3: Public and Private Finance of PPPs

Questo lavoro teorico analizza il ruolo svolto dalle restrizioni finanziarie pubbliche e private nella scelta del governo tra PPP e appalti tradizionali. Diversamente dalla letteratura precedente, vengono introdotti un vincolo privato di responsabilità limitata e un vincolo di bilancio pubblico in un ambiente caratterizzato da informazione asimmetrica. In tale contesto, gli agenti privati vengono protetti, in caso di risultati non soddisfacenti, nei confronti della possibilità di fallimento. Inoltre, i trasferimenti pubblici rappresentano un costo per la società (costo ombra dei fondi pubblici).

Nel PPP, il consorzio privato, grazie al suo coinvolgimento a lungo termine nel progetto, è implicitamente incentivato ad investire durante la fase di costruzione. Di conseguenza, l'agente può accettare livelli di rischio maggiori ed il governo è in grado di risparmiare rendite informative.

Tale analisi teorica fornisce una possibile spiegazione all'evidenza empirica che mostra come i governi con maggiori vincoli di bilancio siano più inclini a scegliere il

PPP. Il risultato non è dovuto alla presenza di finanziamenti privati, ma deriva dall'introduzione dell'assimetria informativa in un contesto di restrizioni finanziarie.

1 Public Private Partnerships: Information Externality in Sequential Investments

Author: Marco Buso

Abstract

This paper studies the benefit coming from bundling two sequential activities in a context of Public Private Partnerships (PPPs). Differently from previous literature, I introduce a source of asymmetric information in the form of an externality parameter linking the building stage with subsequent operational activity.

Within this framework, PPPs allow the government to extract private information about the sign and magnitude of the externality parameter and to to minimize the informational rents needed to incentivize the builder's effort.

Our results suggest how PPPs can become those commitment devices that force governments to define more coherent and informed plans that optimize the first period welfare, improving investment to reduce unexpected ex post costs (cost overruns).

1.1 Introduction

The realization of a public infrastructure with the aim of providing services to citizens represents a long term project characterized by several complexities that must be adequately taken into account to achieve satisfactory results. Decisions about the optimal strategy to realize these investments have increasingly come to coincide

with a choice between a traditional procurement (TP) mechanism and public-private partnerships (PPPs). In the case of TP, the public institution allocates the several stages of the project to different private firms (unbundling), but it remains the owner of the infrastructure, the only financer and it is fully accountable for poor results. In the case of PPPs, a single private consortium made up of several firms is in charge of realizing and managing the infrastructure (bundling). It can assume the role of financer and the risks are optimally shared between public and private partners.

The literature has highlighted several advantages of PPPs over TP. First, the bundling mechanism can create a stronger incentive to innovate and invest in the quality of the infrastructure during the building stage (Martimort and Pouyet, 2008; Iossa and Martimort, 2008). Second, a PPP optimally allocates risks between the two sectors. Consequentially, the private partner has a stronger incentive to apply more effort during the operational stage. Third, this option is able to attract private financers that can act as monitors reducing the information asymmetry between the government and the private agent (Iossa and Martimort 2011).

Since the 1990's, real world PPPs have become common in most developed and developing countries, in a wide array of sectors and typologies; from standard projects where the main sources of revenues were user fees (e.g., motorways, parking facilities, public transport) to very complex projects in which the private profits came essentially from government subsidies (e.g., hospitals, schools, prisons).

Differences between theory and practice arise from the interpretation of the bundling effect. The theory emphasizes the potential benefits of PPPs in exploiting the presence of ex ante positive externalities (Iossa and Martimort, 2008, Martimort and Pouyet, 2008). The practice reveals, instead, the capacity of PPPs to optimally use a particular private expertise for providing public services; i.e., the ability to recognize innovative channels linking the different stages of the project. This paper restores a connection between the theoretical background and the practical evidence. Indeed, the analysis describes a model in which the working agents privately know how and how much the two sequential investment stages are related (differently from Martimort and Pouyet, 2008 and Iossa and Martimort, 2008). Applications of this theoretical proposition to real world cases are represented by all those contractible innovations related to the building stage of the project whose impact on the succeding managerial activity is not ex ante perfectly recognized by the government; e.g., the development of an automatic metro, the improvement of the road's safety

net, the realization of sustainable (green) public buildings. In such cases, public administrations know their own needs, but not what is the best way to achieve their objectives (Iossa and Russo 2008). Long-term commitment devices, such as PPPs, could grant institutions, politicians and administrative workers more useful decision-making information.

The model is developed in an asymmetric information framework and it is based on the "new economics of regulation" and contract theory approach [1]. The theoretical methodology assumes that the principal (government) is able to write contracts contingent on realization of contractible variables that are verifiable ex post[2]. The "project" consists of two sequential stages that are connected through a production externality that links the operational costs with the first phase outcomes. The sources of asymmetric information are not limited to the externality parameter (hidden information), they also include the efforts of the private agents that are not directly verifiable by the principal (hidden action). The government must choose between TP and PPPs with the aim of maximizing the net social welfare produced by the investment taking into account the shadow cost of public funds induced by the transfer of rents from the public to the private agents. The final results reveal a potential ex ante advantage to choosing PPPs that increases with the extent to which future private information is uncertain to the public buyer[3]. The analysis has been further generalized by considering, as a robustness check, the possibility of the government executing, under TP, simultaneous contracts with both agents at the beginning of the project. The benefit of PPPs partially holds in the new framework if the shadow cost of public funds is positive.

1.2 Review of related literature

The literature on PPPs is focused on identifying how problems, like incompleteness of contracts and asymmetric information, influence the organizational management of a multi-period public investment.

[1] This strand of literature applied to the procurement context is connected with the book by Laffont and Tirole (1993).

[2] Even if this hypothesis seems too strong for very complex PPPs, real world experience shows that verification of quality/efficiency may be relatively easier in some sectors (e.g., highway quality) than in others (e.g., hospitals).

[3] That is higher when the variance of the private information parameter is higher.

The incomplete contract approach is the more developed and it is based on a setting in which a contract is not able to cope with every aspect of the economic relationship between the partners. Starting from this insight, the model of Hart (2003) studies the pros and cons associated with a PPP, focusing on the builder's investment decisions in the current period regarding some public infrastructures, given his commitment to running the infrastructure in a future period. Hart concludes that the PPP is the best solution if the quality of the service can be well identified, while the quality of the building shouldn't be explicitly stated in the contract.

Following the incomplete contract methodology, Martimort and Pouyet (2008) together with Iossa and Martimort (2008) develop a two-stage model introducing an externality parameter as a connection between the stages of the project. This parameter is known from the beginning and it is negative in cases where the first stage investment increases the second stage costs, while it is positive otherwise. Their conclusion are driven by the externality variable, inasmuch as the bundling mechanism (PPPs), which internalizes costs and benefits related to the second period activity, is socially preferable only when the externality is positive. Martimort and Pouyet (2008) expand their basic model to allow for general schemes[4], more complete contracts, and introducing an adverse selection issue concerning operating costs. They conclude that, with a benevolent decision-maker and a privately informed operator, the optimal organizational form is still bundling (PPP) when the externality is positive.

The potential advantages of PPPs highlighted by the literature can be partially or totally neutralized in a context of future uncertainty (exogenous shocks) or by considering agency problems within the private consortium. In the first case, the PPP option implies an excessive transfer of risks to a risk adverse consortium and a lack of flexibility induced by early commitment (Iossa and Martimort, 2008, 2011; Martimort and Straub, 2012). In the second case, imperfect bundling leads to a suboptimal privately negotiated incentive structure within the consortium and reduces the scope for welfare-improving PPPs (as compared to Traditional Procurement; Greco, 2013).

Most of the existing literature assumes that the government is able to commit to a multi-period contractual relationship. When that is not the case, the government

[4] The builder's payment depends on the operator's cost.

seeks to renegotiate the contract at the second stage of the project affecting, as a consequence, the first period system of incentives[5] (Guash et al., 2007; Engel et al., 2009; Valéro, 2012). This problem creates contract distortions that directly affect investment costs and successful probabilities.

With the introduction in the U.K. of the private finance initiative (PFI) program in 1992, much emphasis has been put on the financial aspect of PPPs. The achievement of "value for money" as well as the attraction of different sources of financing became the main goals of practitioners and public institutions when starting PPPs. Nevertheless, the theoretical literature mainly analyzes the contractual aspects and implications of these investments, while it is not common to approach the analysis from a financial viewpoint. The main related contributions come from Engel et al. (2010, 2013) and Auriol and Picard (2013). Engel et al. (2013) state the "irrelevance result" according to which there are no public financial advantages of PPPs with respect to TP due to the participation of private financing. Indeed, PPPs cannot be justified by their freeing of public funds inasmuch as public sector current saving in the form of distortionary taxation is perfectly balanced by future looses of public revenue. Auriol and Picard compare a public regime to a build-operate-transfer (BOT) contract for the realization of investment of public and private interests. They build a model within a setting characterized by asymmetric information[6] and in which there is a shadow cost of public funds (λ). The analysis highlights a trade off between the public cost of financing a project and higher prices set by concession holders. A major role in addressing this trade-off is played by distortionary taxation. Indeed, there exists a specific threshold λ_0 such that BOT contracts are preferred if and only if $\lambda > \lambda_0$.

Differently from the previous literature, I develop a theoretical model with the presence of both moral hazard and adverse selection. The hidden information problem is related to the externality parameter that connects the two investment stages, while the hidden action issue concerns the non verifiable agents' efforts.

The study reveals a potential benefit associated with PPPs, in a context of contractible outcomes and incremental innovations. Like contributions to the literature of reference, the paper permits one to better understand how the government in-

[5] At the first period contractual stage, the good firm has incentive to mimic the bad one, knowing that the informed principal will be able to extract its surplus at the second period. This problem is known as the "ratchet effect".

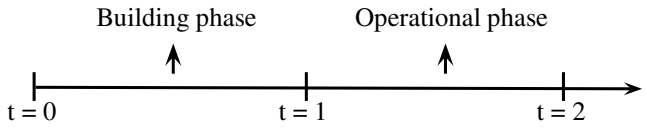
[6] The concession holder faces a much weaker information asymmetry with their own manager compared to the government.

vestment decision is affected when the externality parameter introduced by Iossa and Martimort (2008) and Martimort and Pouyet (2008) becomes uncertain. Furthermore, the analysis goes farther than Engel et. al. (2013) by showing how the shadow cost of public funds comes to be relevant in driving the government choice between TP and PPPs, in a context of sequential investments of public interest with multiple sources of asymmetric information.

The paper is organized as follows: Section 3 lays out the model; Sections 4 and 5 discuss the unbundling and the bundling scenarios; Section 6 analyzes the net surplus produced by the different scenarios through a welfare analysis; Section 7 concludes.

1.3 The Model

The government aims at the realization of a public infrastructure able to provide services for its citizens. The project is made up of two stages: the construction of the public asset and the provision of services.



The realized facility generates a social surplus equal to $CS = S_0 + S * I(e_1)$. The surplus can be divided into two components: a constant term (S_0) that depends on the realization of the basic infrastructure and a second part that linearly depends on an incremental innovative investment $I(e_1)$ that is contractible and increasing with the builder's effort ($I(e_1) = e_1 + \epsilon$ where $\epsilon \sim g(0, \sigma_\epsilon^2)$ and $g(\epsilon) \sim [\epsilon^l, \epsilon^h]$). The effort ($e_1$) is not verifiable by the government and it implies a non monetary disutility for the builder equal to $\psi(e_1)$ that, by assumption, satisfies the following properties: $\psi' \geq 0$, $\psi'' \geq 0$ and $\psi(0) = 0$.

In the analysis the government is assumed to be benevolent and able to commit to a long term project. It acts as a principal and writes the contracts to maximize the social welfare function.

$$W^G = S_0 + S * I(e_1) + U - (1 + \lambda)T \tag{1.1}$$

The function is the sum of social surplus ($CS = S_0 + S * I(e_1)$) and the firms' utilities (U), net of the government's expenses (T) weighted by the shadow cost of public funds (λ) that captures distortion imposed on taxpayers to collect the money needed for the investment[7].

The first stage of the project is entrusted to a builder whose utility is defined as follows:

$$U_1 = T_1 - \psi(e_1) \tag{1.2}$$

The builder is in charge of the construction of the basic infrastructure, which entails a fixed cost that is totally reimbursed and a non-monetary disutility of effort. As compensation, he receives a transfer that increases with the level of innovation introduced in the project.

The second stage activity is assigned to an operator who receives, in return for his services, the following utility:

$$U_2 = T_2 - [O - e_2(\theta) - I(e_1)\theta] - \psi(e_2) \tag{1.3}$$

The return to the operator is composed of the gross transfer from the government net of the monetary cost ($C_2(\theta) = O - e_2(\theta) - I(e_1)\theta$) and a non-monetary disutility of effort ($\psi(e_2)$). The monetary cost is verifiable and observable. It is determined by: the fixed part O; the cost-reducing effort e_2; and the impact of the first stage investment on the second phase. This last effect is driven by θ, which reflects the private information of the operator. This parameter defines whether or not the builder's investment increases (negative externality $\theta < 0$) or reduces (positive externality $\theta > 0$) the operational costs[8]. The agent is able to acquire this information during

[7]The model follows the approach used in the procurement model of Laffont and Tirole (1986)

[8]For istance, an automatic metro may reduce the need for drivers (positive externality). Never-

the building stage when the main features of the infrastructure become observable (this parameter can represent the combination of private information of the builder and the operator about the cost to manage the realized asset)[9]. The government cannot directly detect the private information, but it can observe the distribution of the variable over a range of values: $f(\theta) \sim [\theta^l, \theta^h]$ where $\int_{\theta^l}^{\theta^h} \theta f(\theta) d\theta = \overline{\theta}$. For the purpose of this analysis, the possible forms that $f(\theta)$ can take have been restricted to the class of piecewise differentiable functions that allow the use of optimal control theory. A further standard requirement regards the hazard rate, $\frac{F(\theta)}{f(\theta)}$, that is assumed monotonic with respect to θ: $d(\frac{F(\theta)}{f(\theta)})/d\theta \geq 0$[10]. In addition to monetary expenses, the operator experiences a non-monetary cost of applying effort captured by the function $\psi(e_2)$ that, by assumption, satisfies the same properties as the builder's effort: $\psi' \geq 0$, $\psi'' \geq 0$ and $\psi(0) = 0$.

For the achievement of the project, the government can choose between two possibilities: unbundling (TP) and bundling (PPPs). In the first case the two stages are managed by different firms while, in the second case, there is a single private consortium that takes care of both stages.

1.4 Unbundling

Within the unbundling (TP) scenario, the government chooses to undertake the two stages of the project through different agents: the builder and the operator. These players act autonomously and the government offers two distinct contracts.

In the first stage the government wants to maximize the builder's effort, but it must cope with a problem hidden action. Therefore, it can only offer an incentive contract based on the level of observable and verifiable outcomes, i.e., a proportional transfer $\{T_1 = I(e_1)t_1\}$ linking the builder's compensation with the investment output $I(e_1)$.

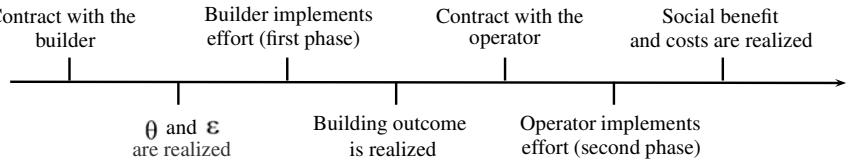
theless, innovative designs or materials for the construction of sustainable public buildings can increase social surplus, but also maintenance costs (negative externality).

[9] This parameter can capture, for example, the impact of the development of an automatic metro on operational costs. The government can forecast what will be the effect of this innovation, but only the operator is able to perfectly compare the saving of costs in the form of lower drivers' salaries with the potential increase in expenses in the form of organizational adaptations and new professional workers' salaries.

[10] This assumption implies that effort decreases with agent inefficiency.

In the second stage the relationship between the principal and the agent is influenced by problems of both hidden information and hidden action. The government can offer a menu of incentive-feasible contracts based on the verifiable outcome and induce truthful revelation of the firm's cost parameter, that is a revelation mechanism $\left\{t(\hat{\theta}), C(\hat{\theta})\right\}_{\theta\epsilon[\theta^l,\theta^h]}$ that defines the cost that the firm has to realize and the net transfer it will receive when the cost parameter $\hat{\theta}$ is announced [11]:

In this scenario, the contractual agreements are signed according to the following timeline:



The purpose of the government is to characterize the perfect Bayesian equilibria of the overall game; the solution of this problem is standard and is found using backward induction.

Second stage of the game

In the second stage the principal writes a contract that gives the operator incentive to apply effort in exchange for the minimum payment of money: a rent-efficiency trade off.

$$\max_{e_2(\theta)} W_2^G = \int_{\theta^l}^{\theta^h} \{U_2(\theta) - (1+\lambda)[t_2(\theta) + C_2(\theta)]\} dF(\theta)$$

s.t.

1- $\quad \frac{dU_2}{d\theta} = -\psi'(e_2(\theta))$

2- $\quad U_2(\theta^h) = 0$

[11] As usual, we know from the revelation principle that any regulatory mechanism is equivalent to a direct revelation mechanism that induces a truthful revelation of the firm's cost parameter. This regulatory mechanism can then implement the optimum through a menu of linear contracts (Laffont and Tirole, 1993).

Proof. See Appendix 2

The government maximizes the net social welfare related to the second period taking into account the agent's information constraints. The contract is offered at the ex post stage, once the agent already knows his type. As a consequence, the participation constraint is binding for the most inefficient operator, who must receive at least his reservation utility (normalized to 0) to accept the contract [2]. Additionally, the government must structure the transfers to optimally induce the truthful revelation of the private agent's information [1][12]. The problem's solution includes the following optimal level of effort:

$$e_2^U(\theta) = \psi'^{-1}[1 - \frac{\lambda}{1+\lambda}\frac{F(\theta)}{f(\theta)}\psi''(e_2^U(\theta))] \tag{1.4}$$

The result is standard for the literature of reference. Indeed, it underscores the role played by asymmetric information that lowers the equilibrium value of effort, compared to the first best results (Appendix 1). If the monotone hazard rate property $d(\frac{F(\theta)}{f(\theta)})/d\theta \geq 0$ holds, the solution for effort is decreasing in θ. Therefore, the distortion is lower the more efficient the firm. On the other hand, all the firms, except the least productive, receive positive utility, and the more efficient the agent, the higher his information rent.

First stage of the game

At the beginning of the first period the government is able to propose a contract that specifies both the parameters defining first period social welfare and the expected second stage value function ($[V_2]$ - the discounted surplus related to the managerial activity; see Appendix 2).

$\underset{e_1}{max} \int_{\epsilon^l}^{\epsilon^h} \{[(S_0 + I(e_1) * S) + U_1(e_1) - (1+\lambda)T_1] + [V_2]\} g(\epsilon) d\epsilon$

s.t.

[12]Otherwise, the efficient type would have incentive to mimic the inefficient agent.

1- $e_1 = \underset{e_1}{argmax} E[U_1]$

2- $E_\epsilon[T_1 - \psi(e_1)] \geq 0$

Proof. See Appendix 2

The objective function of the government is composed of the social surplus deriving from the realization of the infrastructure, the expected second stage value function, and the builder's payoff net of the government's costs, weighted by the shadow cost of public funds. The random shock ϵ is realized after the conclusion of the contract. Therefore, the participation constraint is defined ex ante [2]. The incentive compatibility constraint [1] takes into account the optimal effort choice for a given contract that comes from the maximization of the agent's ex ante utility. The problem's solution includes the following result:

$$\psi'(e_1^U) + \lambda \frac{dT^*}{de_1} = S + (1+\lambda)\overline{\theta} \tag{1.5}$$

where $\frac{dT^*}{de_1} = \psi'(e_1^U) + \psi''(e_1^U)e_1^U$

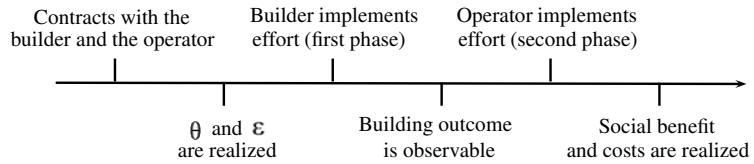
The first order condition equalizes the expected marginal benefit (right hand side) with the marginal cost (left hand size). Increasing the level of effort creates a current benefit for the society as well as a possible future saving of operating costs when the expected externality between the two stages is positive ($\overline{\theta} > 0$)[13]. On the other hand, a greater level of effort makes the operator suffer a higher non-monetary disutility, and marginally increase the transfer at the optimum to the private agent. The main parameters entering Equation 5 are the expected externality value ($\overline{\theta}$) and the shadow cost of public funds (λ). $\overline{\theta}$ affects the marginal benefit negatively or positively, depending on whether the investment realized during the first phase increases or decreases (in expectation) the costs needed to manage the infrastructure. λ captures the distortion imposed on taxpayers when public money is transferred to the private builder ($\lambda \frac{dT^*}{de_1}$). Moreover, it enlarges the expected positive or negative impact of the externality parameter ($(1+\lambda)\overline{\theta}$).

[13] If the expected externality is negative ($\overline{\theta} < 0$), the total level of expected marginal benefit decreases.

1.4.1 A Robustness check: simultaneous contracts

The previous analysis describes what normally happens in real world situations in which public procurement contracts related to multi-stage projects are signed and outcomes of previous stages are already observed by both parties. As an alternative to this strategy, the government could define ex ante, i.e., before investment begins, all the contracts with multiple agents. This option is theoretically feasible, but, pratically, it is not implemented. Indeed, linking an agent's obligations to future outcomes of different contracts is normally not allowed by the legal system.

In this section, I expand the previous framework, allowing for the possibility of writing simultaneous contracts at the beginning. This is a theoretical exercise that functions as a robustness check on the preceding analysis of the unbundling structure. In this scenario, the timeline of the game is as follows:



Proof. See Appendix 2

The results finally obtained are described by the following equations.

$$\psi'(e_1^S) + \lambda \frac{dT^*}{de_1} = S + (1+\lambda)\theta \tag{1.6}$$

where $\frac{dT^*}{de_1} = \psi'(e_1^S) + \psi''(e_1^S)e_1^S$

$$e_2^S(\theta) = \psi'^{-1}[1 - \frac{\lambda}{1+\lambda}\frac{F(\theta)}{f(\theta)}\psi''(e_2^S(\theta))] \tag{1.7}$$

Equation 6 describes the builder's optimal effort. Compared to the sequential contracts scenario, the marginal benefit is different. Indeed, the positive or negative

impact of the first stage investment to the second stage costs is driven by the real value of θ which is actually defined in the ex ante contract between the government and the operator. Equation 7 describes the operator's optimal effort, which does not change from the sequential contracts case[14].

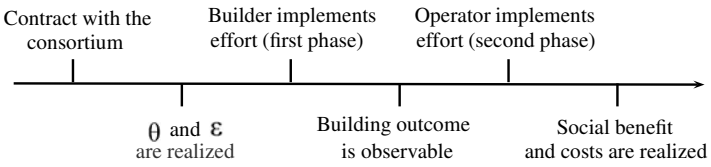
1.5 Bundling

Within this setting the approach and the initial assumptions are very similar compared to the unbundling scenario. There is a single private agent (consortium) that sustains a cost over the two periods dependent on the same parameters as before, and based on an ex ante information structure that does not change with the new environment. The consortium receives compensation for its activities, which is defined as the sum of the builder's and the operator's utilities:

$$U_B = T_1(e_1) + T_2(\theta) - C(\theta) - \psi(e_1) - \psi(e_2(\theta)) \tag{1.8}$$

The government can offer, in this case, a menu of incentive-feasible contracts based on verifiable outcomes that must induce truthful revelation of the operator's cost parameter and enhance first period investment, i.e., a triplet, $\left\{t_1(\hat{\theta}), t_2(\hat{\theta}), C_2(\hat{\theta})\right\}_{\theta\epsilon[\theta^l,\theta^h]}$, which respects the incentive constraints and defines costs and transfers when the private parameter $\hat{\theta}$ is announced.

In this scenario, the time-line of the game takes the following form:



[14]In this section, I implicity assume that the government cannot commit to leaving the agent with a negative ex post utility. This hypothesis is plausible given that the operator gets the private information before the activity starts. Nevertheless, if this is not the case, the government's optimal strategy consists of offering a fixed price contract: $t_2(C_2) = a - C_2$, where $a = \int_{\theta^l}^{\theta^h} \{\psi(e_2(\theta)) + C_2(\theta)\} d\theta$. The operator, as residual claimant, makes the efficient decision, receives no rents in expectation and takes the risk of having a negative ex post utility. Taking the analysis in this direction does not change the core results of the analysis.

The screening strategy proposed by the government forces the consortium to truthfully reveal its private information when it becomes observable. The government maximizes the net social welfare produced by the project over the two periods taking into account the incentive-feasible constraints.

$$\underset{e_1,e_2(\theta)}{max} \int_{\epsilon^l}^{\epsilon^h} \{\int_{\theta^l}^{\theta^h} \{[S_0 + I(e_1) * S] + U_B - (1+\lambda)[I(e_1)t_1 + t_2(\theta) + C_2(\theta)]\} f(\theta) d\theta\} f(\epsilon) d\epsilon$$

s.t.

1- $e_1 = \underset{e_1}{argmax} E[U_B]$

2- $\frac{dE[U_B]}{d\theta} = -\psi'(e_2(\theta))$

3- $E_\epsilon[I(e_1)t_1 - \psi(e_1) + t_2(\theta) - \psi(e_2(\theta))] \geq 0$

Proof. See Appendix 3

The government's goals are the maximization of social surplus and the agents' extraction of rent. On the other hand, it must take into consideration the firms' incentives and interests, which are embodied in the three constraints. The first equation incents the agent to apply effort during the building stage [1]. The second equation represents the mechanism needed to obtain a truthful revelation of the private information parameter [2], while the third equation reflects the participation constraint, which is binding for the more costly type [3]. The maximization solution leads to the following outcomes:

$$\psi'(e_1^B) + \lambda \frac{dT_B^*}{de_1} = S + (1+\lambda)\theta \tag{1.9}$$

where $\frac{dT_B^*}{de_1} = \psi'(e_1^B)$

$$e_2^B(\theta) = \psi'^{-1}[1 - \frac{\lambda}{1+\lambda} \frac{F(\theta)}{f(\theta)} \psi''(e_2(\theta))] \tag{1.10}$$

The operator's level of effort (Equation 9) does not change at the optimum, compared to its level under unbundling[15]. Equation 10 reports the builder's effort. Differently from the unbundling scenario, the contract with the consortium is made before the start of the investment. Therefore, thanks to the revelation mechanism, the information becomes contractible since the first stage and the optimal level of builder's effort can be set on the basis of the real value of θ announced by the operator. A further difference with the unbundling context (both sequential and simultaneous contracts) comes from the distortionary cost that the society incurs for a marginal transfer from the government to the private agent. In the case of PPPs, the principal has the opportunity to leave the consortium with no ex ante private rent at the optimum lowering the total marginal cost (left hand side of Equation 9). This is possible because the government has the further ability, compared to TP, of optimally setting the incentive compatibility transfers, while keeping the ex ante participation constraint (over the two periods) binding.

Similarly to the previous case, the main parameters entering the outcomes equations are the shadow cost of public funds λ and the externality parameter θ. λ increases the marginal cost of effort, and it magnifies the effect of the externality. θ captures the positive or negative impact of the first stage investment on the second period costs. In contrast to the unbundling scenario, in this case, the builder's investment decision is directly affected by θ, and not only by its average value.

1.6 Welfare analysis

In this section we compare the bundling and the unbundling scenarios in terms of ex ante social welfare, with the purpose of identifying the factors that drive the choices of governments facing informational settings similar to the one modeled in this paper.

[15] As in the unbundling case with simultaneous contracts, in this section, I implicity assume that the agent cannot commit not to exit the contract when he discovers θ. This is plausible given that the operator gets the private information before the activity starts. Nevertheless, if it is not the case, the government's optimal strategy consists of offering a second term fixed price contract: $t_2(C_2) = a - C_2$, where $a = \int_{\theta^l}^{\theta^h} \{\psi(e_2(\theta)) + C_2(\theta)\} d\theta$. In such a situation, the bundling mechanism could further increase the builder's effort, inasmuch as the distortion induced by adverse selection will disappear. Alternatively, if the analysis is generalized to relax this assumption, the potential benefits of PPPs will increase.

The Welfare analysis is performed using the expected value of the objective function of the government over the two periods: $E_{\theta,\epsilon}[S_0 + S * I(e_1) + U_1 + U_2 - (1+\lambda)(t_1 + t_2 + C_2)]$. In this paragraph, it is assumed that $\psi(e_1) = \frac{e_1^2}{2}$ and $\psi(e_2) = \frac{e_2^2}{2}$. These functions respect the initial assumptions of the model and allow us to compute the value of the agents' efforts at the optimum. The analysis is reported in Appendix 4. The result is summarized by the following formula, which describes the difference in value functions between the levels of social welfare produced under bundling and unbundling:

$$V_B - V_U = W_n = \{RS\} + \{IE\} = \left\{ \frac{\lambda}{2(1+\lambda)(1+2\lambda)} (S + (1+\lambda)\overline{\theta})^2 \right\} + \left\{ \frac{(1+\lambda)}{2} \sigma_\theta^2 \right\} \quad (1.11)$$

where

$RS = \frac{\lambda}{2(1+\lambda)(1+2\lambda)} (S + (1+\lambda)\overline{\theta})^2$ - Rent Saving
$IE = \frac{(1+\lambda)}{2} \sigma_\theta^2$ - Information Externality

The result can be decomposed in two effects that are explained in detail in the following definitions:

Rent saving effect (RS): This effect is always positive or equal to zero. It reflects the ex ante marginal benefit to the society $(S + (1+\lambda)\overline{\theta})$ deriving from the builder's higher investment under bundling, when $\lambda > 0$. PPPs allow the principal to recover the first period incentive rents during the lifetime of the investment without affecting the second period incentive compatibility constraint. As a consequence, the government can optimally align the agent's incentives and maximize the total extraction of rents[16]. This effect is meaningful inasmuch as the contracts are costly for society ($\lambda \geq 0$). Moreover, the additional transfer of risks to the private consortium does not affect the agent's utility, because of the assumption of risk neutrality. The introduction of a coefficient of risk aversion would have changed the final results.

Information externality effect (IE): This effect is always positive or equal to zero. PPPs commit the government to define a more informed investment plan,

[16]The rent efficiency trade off is more slack.

taking into account every short term and long term relationships between the builder's investment and the future stages of the project. Precisely, bundling the two tasks allows the government to internalize the operator's private information in the builder's innovative investment. This effect increases with the uncertainty of the private information parameter; therefore, if the variance decreases, the private information is less valuable to the operator, and there is a lower benefit from choosing PPPs.

These effects lead to the following proposition, which summarizes the main result of the paper:

Proposition 1: In a context characterized by non-verifiable effort and hidden information on θ (the externality is uncertain for the government), bundling strictly dominates unbundling when the following conditions are satisfied:

- Long term contracts based on verifiable outcomes can be signed;

- Agents are risk-neutrals;

- Either the shadow cost of public funds or the variance of θ is different from zero.

Proposition 1 emphasizes the role of the externality parameter θ as well as the influence of the shadow cost of public funds λ. Figures 1 and 2 help one better understand the effects of these parameters on the government welfare function.

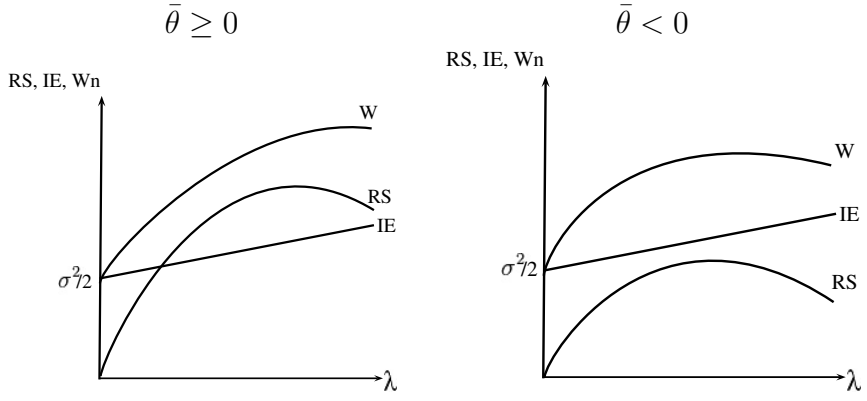


Figure 1: Net welfare function (Wn) with respect to λ

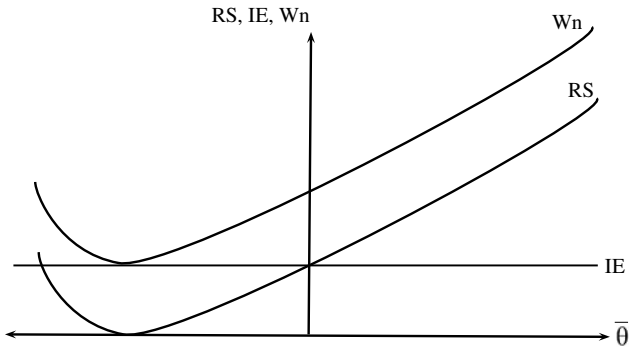


Figure 2: Net welfare function (Wn) with respect to $\bar{\theta}$

The graphs display the net welfare surplus of the government ($W_n = V_B - V_U$) and its components (the RS and the IE effects) with respect to λ and $\bar{\theta}$ (the expected externality parameter).

The IE effect linearly increases with λ, while the RS dynamic is less clear. When the externality is positive or equal to 0, the RS effect initially rises with the shadow cost of public funds, but it can exhibit negative dependence for sufficiently high values of λ[17]. On the other hand, when the externality is negative, the threshold value of λ that determines a change in the direction of this relationship is lower[18] (Proof: See Appendix 5). The net surplus W_n that is the result of the two effects is higher than 0 for every value of λ, and it follows a trend that is either always increasing or initially increasing and decreasing thereafter, depending on which of the two effects dominates. Figure 2 shows the dynamics of W_n, IE and RS effects with respect to $\bar{\theta}$. The highest gain in the form of net surplus by choosing PPPs is reached when the expected externality is positive or very negative (Proof: See Appendix 5).

When PPPs are compared to TP mechanisms, several factors must be taken into consideration, such as: the degree of completeness of the contracts; the presence

[17]When λ is very high, the level of optimal innovative investment decreases; there is less need of incentive rents. Therefore, the potential benefit of bundling in terms of rent-saving is lower.

[18]When the externality is negative, a rise in λ increases the negative effect of first stage investment on operational costs. This negative impact is internalized by the government in the form of lower builder's investment. As a consequence, the incentive transfers decrease and the potential benefit of bundling in terms of rent-saving is lower.

of asymmetric information; the degree of agents' risk aversion; the level of production uncertainty. This model does not aim to completely explain what drives a government's choice between PPPs and TP, but it develops two points previously introduced by the theoretical literature on PPPs: the externality parameter (Iossa and Martimort, 2008; Martimort and Pouyet, 2008) and the basic public finance of PPPs (Engel et al., 2013; Auriol and Picard, 2013).

Differently from the previous analyses, it has been assumed that the government does not know ex ante the real impact of the first stage investment on operational costs. This assumption is plausible in contexts where the first period investment is not standard, but its short term and long term effects are ex ante measurable. Thus, the government cannot rely on previous experience, while the agent is able, through its better market knowledge, to assess the long term implications of the investment. Within this framework, bundling dominates unbundling not only when the first stage investment decreases the operational costs (Iossa and Martimort, 2008; and Martimort and Pouyet, 2008), but also when the externality is negative. Indeed, bundling two tasks allows the government to extract through the contract, ex ante, the private information of the operator. Considering this externality, the principal has the opportunity to establish a more informed investment plan capable of either incenting the builder's effort, when the externality is positive, or avoiding excessive operational costs and rents, when the externality is very negative. It is no longer the sign that is the main driver of the analysis, but the results are finally determined by the variance of the externality parameter and by the size of the expected externality value (either negative or positive)[19]. Whether it is the sign, the size or the variance of the externality that matters for the optimal organizational choice depends on the presence of asymmetric information about θ, on the level of completeness of the contract and on the degree of risk aversion of the private agents.

As a further contribution, this paper focuses on the impact of PPPs on the government budget. Engel et al. (2013) show that PPPs do not release public funds. Therefore, the distortionary cost of taxation is not a rationale for the use of PPPs. This paper goes farther in the analysis, introducing a situation of multiple asymmetric information in multi stage public investment. In such a context, PPPs commit the agent not to exit the contract, accounting for the fact that he can experience a second period incentive transfer of money. As a consequence, the government can op-

[19]Fig. 2 shows how the net welfare function of the government increases when the size of the expected externality (positive or negative) is greater.

timize first stage investment, maximizing total rent extraction. Thus, the relevance of λ is driven by the asymmetry of information, and it depends on the government's ability to optimally enhance the builder's investment at minimum cost. Elements that do not affect the analysis are, instead, the share of private financing and the nature of the agents' revenues (user fees or government transfers)[20].

1.6.1 A Robustness check: simultaneous contracts

In the unbundling scenario, the government can theoretically execute the contracts with both the builder and the operator before starting the project. In such a framework, the welfare function produced under unbundling is modified. As a consequence, the difference in value functions between the two scenarios changes (Appendix 5), and this is summarized by the following formula:

$$V_B - V_U^S = \{RS\} + \frac{\lambda}{(1+2\lambda)}\{IE\} = \left\{\frac{\lambda}{2(1+\lambda)(1+2\lambda)}(S+(1+\lambda)\overline{\theta})^2\right\} + \left\{\frac{\lambda(1+\lambda)}{2(1+2\lambda)}\sigma_\theta^2\right\} \quad (1.12)$$

When compared to the standard case, we observe that the two effects still hold in the new environment, but the IE impact is weakened. Indeed, if simultaneous contracts can be written, the government is also able to extract the private information of the operator in the undundling scenario ex ante. Thus, the benefits of PPPs decrease. What drives the result described by Equation 12 is the hidden action problem that complicates the building stage. In fact, under PPPs, the government can optimally make the first stage investment at minimum cost, while, under TP, it is more costly for the government to define the incentive mechanism and, hence, the impact of the externality on the optimal builder's investment is also reduced. The main consequences of this change are described by the following proposition:

[20] These final results are in accordance with Engel et. al. (2007) and come from a different channel with respect to the one highlighted by Auriol and Picard (2013).

Proposition 2: In a context characterized by simultaneous contracts, non-verifiable effort and hidden information on θ , bundling strictly dominates unbundling when the following conditions are satisfied:

- Long term contracts based on verifiable outcomes can be signed;

- Agents are risk-neutral;

- The shadow cost of public funds (λ) is strictly positive.

Proposition 2 differs from Proposition 1 essentially in the role played by the shadow cost of public funds. Indeed, where λ is equal to 0, the two scenarios are identical. In conclusion, when simultaneous contracts are written, the difference in value functions between bundling and unbundling is less dependent on the variance of the externality parameter (σ_θ^2), but more related to the shadow cost of public funds (λ).

1.7 Conclusion

This paper discusses the choice between PPPs and TP mechanisms for the realization and management of long term projects in contexts where the future consequences of short term investment are uncertain and governments do not share all the relevant information known to private agents.

The study focuses on the role of the externality between the building and the operational stage, treating it as the main source of asymmetric information. Differently from previous results in the literature, in the current analysis, the comparison between PPPs (bundling) and TP (unbundling) does not depend only on how and how much the different activities of the project are related, but it is also related to prior government knowledge. More precisely, when the effects of first stage investment on the operational stage are very uncertain, the government is pushed toward PPPs, which permit it to extract, ex ante, the agent's private information and to optimally control, as a consequence, the builder's investment.

When looking at real world cases, this effect can help us to understand why cost overruns are lower when PPPs are used (EPEC 2011, EIB 2005). In infrastructure projects, estimated costs are often different from their ex post realizations. One explanation for this gap derives from the substantial uncertainty that characterizes

ex ante evaluations. PPPs allow the government to collect more information at the beginning of the project. As a consequence, ex ante evaluations are more precise and large cost overruns less likely.

Another result of the analysis is that, the shadow cost of public funds (λ), is relevant to social welfare. In fact, when asymmetric information is introduced in projects with interrelated sequential stages, PPPs facilitate government's task, allowing it to put in place an incentive mechanism that takes the two stages of the project into account at the beginning. Accordingly, incentives are more aligned, and performance rents become less costly to society.

The implication is that PPPs are particularly advantageous when long term risks associated with public investments are not easily assessed ex ante by governments, but performance can be verified ex post. Neither standardized projects nor R & D investments meet this requirement. What matters is both the ability of private agents to use their special expertise to evaluate innovative projects and the ability of governments to execute contracts on the basis of future outcomes. (All projects that involve new applications of existing innovations are suitable examples of the case of interest.) The advantage of PPPs increases when the initial investment is particularly important, in expectation, to the second period activity, or in situations of public budget stress. In both cases, PPPs imply substantial gains in the form of fewer cost overruns and lower incentive rents.

Several extensions could enrich the current analysis.

Different degrees of contracts' completeness couls be introduced. Depending on the ability of governments to write contracts based on verifiable future outcomes, the analysis would be more or less driven by the sign of the externality (incomplete contract - Iossa and Martimort, 2008; Martimort and Pouyet, 2008) or by the variability of the externality (more complete contracts).

In this paper, I have shown how governments, using PPPs, can optimally put in place an incentive mechanism maximizes the agents' rent extraction. As a consequence, the private consortium is left with a binding ex ante participation constraint, while its ex post utility, compared to the TP scenario, is more likely to decline. This additional uncertainty does not represent a cost in a context of risk neutrality, but if agents are risk averse the benefit of PPPs' in terms of rent saving will be lower.

In the model it has been assumed that there is no divergence of objectives within the consortium. Therefore, perfect sharing of information and profits among consortium

participants can be attained. As a further refinement, this assumption could be relaxed (Greco 2013). In such a case, PPPs would guarantee neither the complete extraction of information nor the perfect cost-minimizing alignment of incentives. The degree to which the results came to be relevant in this more general framework would depend on the information structure within the private consortium.

Finally, it is important to highlight that the preceding study is based on the assumption that the government can commit to long term contracts. If this is not the case, the principal has the incentive to extract all the second stage rent after the revelation of the operator type, upon execution of the initial contract. Anticipating this strategy, the consortium seeks to maximize its first period payoff, and a separating contract is not always implementable (ratchet effect)[21]. What would be an interesting refinement of the preceding analysis would be an extension designed to assess the robustness of the final results to different degrees of government commitment.

[21] This problem has already been investigated by Valéro (2012), who shows how, even under government opportunism, there is the possibility of welfare improving PPPs.

1.8 Appendix

1 - First Best Benchmark

The government maximizes the total welfare function, there are no problems of hidden information or hidden action

$$\max_{e_1,e_2(\theta)} \int_{-\epsilon}^{+\epsilon} \{S_0 + I(e_1) * S - (1+\lambda)[I(e_1)t_1 + t_2(\theta) + C_2(\theta)] \\ +I(e_1)t_1 + t_2(\theta) - \psi(e_1) - \psi(e_2(\theta))\} g(\epsilon) d\epsilon$$

The government can totally extract agents' rents

$$\max_{e_1,e_2(\theta)} \int_{-\epsilon}^{+\epsilon} \{S_0 + I(e_1) * S - (1+\lambda)[\psi(e_1) + \psi(e_2(\theta)) + C_2(\theta)]\} g(\epsilon) d\epsilon$$

Optimizing w.r.t. e_1 and $e_2(\theta)$ yelds respectively

$$\psi'(e_1^{FB})(1+\lambda) = S + (1+\lambda)\theta$$
$$\psi'(e_2^{FB}(\theta)) = 1$$

2 - Proof of the Unbundling Problem

Let us solve the problem backward

Second stage of the game

The government maximizes the second stage welfare function taking into account the operator's incentive constraints:

$$\max_{e_2(\theta)} \int_{\theta^l}^{\theta^h} \{t_2(\theta) - \psi(e_2(\theta)) - (1+\lambda)[t_2(\theta) + O - e_1\theta - e_2(\theta)]\} dF(\theta)$$
s.t.

1- $\frac{dU_2}{de_2(\theta)} = -\psi'(e_2(\theta))$

2- $U_2(\theta^h) = 0$

The ex post participation constraint is binding for the least efficient agent. The incentive compatibility constraint that derives from the application of the envelope theorem allows us to compute the agent's utility

$$U(\theta) = \int_{\theta}^{\theta^h} \psi(e_2(\tilde{\theta}))d\tilde{\theta} + U(\theta^h)$$

Integrating by parts we can compute the expected rent granted to the operator by the principal

$$\int_{\theta^l}^{\theta^h} \{U(\theta)\}f(\theta)d\theta = \int_{\theta^l}^{\theta^h} \{\int_{\theta}^{\theta^h} \psi(e_2(\tilde{\theta}))d\tilde{\theta}\}f(\theta)d\theta = \int_{\theta^l}^{\theta^h} \{\frac{F(\theta)}{f(\theta)}\psi'(e_2(\theta))\}f(\theta)d\theta$$

Substituting the constraints into the government's function, we obtain the principal's optimization problem:

$$\underset{e_2(\theta)}{max} W_2 = \int_{\theta^l}^{\theta^h} \{-(1+\lambda)[O - e_1\theta - e_2(\theta) + \psi(e_2(\theta))] - \lambda[\frac{F(\theta)}{f(\theta)}\psi'(e_2(\theta))]\}f(\theta)d\theta$$

Optimizing w.r.t. e_2 yelds to the optimal level of effort, just like is reported in the text

$$\psi'(e_2^U(\theta)) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\theta)}{f(\theta)}\psi''(e_2^U(\theta))$$

Substituting the optimal level of effort in the objective function of the government and solving the integral, we obtain the value function of the government

$$V_2 = -O + (1+\lambda)e_1\overline{\theta} - \int_{\theta^l}^{\theta^h}\{(1+\lambda)[-e_2^U(\theta) + \frac{(e_2^U(\theta))^2}{2} + \frac{\lambda}{1+\lambda}\frac{F(\theta)}{f(\theta)}\psi''(e_2^U(\theta))]\}f(\theta)d\theta$$

First stage of the game

The government maximizes the sum of the first stage welfare function and the second stage value function taking into account the builder's incentive constraints:

$$\underset{e_1}{max}\int_{\epsilon^l}^{\epsilon^h}\{S_0 + I(e_1) * S - (1+\lambda)[I(e_1)T] + I(e_1)t_1 - \psi(e_1) + V_2\}g(\epsilon)d\epsilon$$

s.t.

1- $\frac{dE_\epsilon[U_1]}{de_1} = 0$

2- $E_\epsilon[I(e_1)t_1 - C_1 - \psi(e_1)] \geq 0$

From the incentice compatibility constraint we can compute the marginal transfer at the equilibrium $t_1 = \psi'(e_1)$; from the participation constraint we obtain the ex ante expected utility: $E_\epsilon[U_1] = e_1t_1 - \psi(e_1)$. Substituting into the government's function, we get the principal's optimization problem:

$$\underset{e_1}{max}W_1 = e_1 + S - (1+\lambda)[e_1\psi'(e_1)] + e_1\psi'(e_1) - \psi(e_1) + V_2$$

Optimizing w.r.t. e_1 yelds

$$\psi'(e_1^U) + \lambda[\psi'(e_1^U) + \psi''(e_1^U)e_1^U] = S + (1+\lambda)\overline{\theta}$$

where $[\psi'(e_1^U) + \psi''(e_1^U)e_1^U] = \frac{dT^*}{de_1}$

A Robustness check: simultaneous contracts

From a theoretical point of view, the government can offer both the operator's and the builder's contracts before the investment start. Withtin this framework, the

government maximizes the total welfare function taking into account the incentive constraints:

$$\underset{e_1,e_2(\theta)}{max} \int_{-\epsilon}^{+\epsilon}\{\int_{\theta^l}^{\theta^h}\{S_0 + I(e_1) * S - (1+\lambda)[I(e_1)t_1 + t_2(\theta) + C_2(\theta)]$$
$$+I(e_1)t_1 + t_2(\theta) - \psi(e_1) - \psi(e_2(\theta))\}f(\theta)d\theta\}g(\epsilon)d\epsilon$$

s.t.

1- $\frac{dE_\epsilon[U_1]}{de_1} = 0$

2- $E_\epsilon[U_1] \geq 0$

3- $\frac{dU_2}{d\theta} = -\psi'(e_2(\theta))$

4- $U_2^h \geq 0$

Substituting the constraints into the government's objective function we obtain the principal's maximization problem:

$$\underset{e_1,e_2(\theta)}{max} W_S = \int_{\theta^l}^{\theta^h}\{S_0 + e_1 S - (1+\lambda)[e_1 t_1 + \psi(e_2(\theta)) + O - e_1\theta - e_2(\theta)]$$
$$+e_1 t_1 - \psi(e_1) - \lambda[\tfrac{F(\theta)}{f(\theta)}\psi'(e_2(\theta))]\}f(\theta)d\theta$$

Optimizing w.r.t. e_1 and $e_2(\theta)$ yelds respectively

$$\psi'(e_1^S) + \lambda\frac{dT^*}{de_1} = S + (1+\lambda)\theta$$
$$\psi'(e_2^S(\theta)) = 1 - \tfrac{\lambda}{1+\lambda}\tfrac{F(\theta)}{f(\theta)}\psi''(e_2^S(\theta))$$

3 - Proof of the Bundling Problem

The government maximizes the total welfare function taking into account the consortium's incentive constraints:

$$\underset{e_1,e_2(\theta)}{max} \int_{\epsilon^l}^{\epsilon^h}\{\int_{\theta^l}^{\theta^h}\{S_0 + I(e_1) * S - (1+\lambda)[I(e_1)t_1 + t_2(\theta) + O - I(e_1)\theta - e_2(\theta)]$$

$$+I(e_1)t_1 + t_2(\theta) - \psi(e_1) - \psi(e_2(\theta))\}f(\theta)d\theta\}g(\epsilon)d\epsilon$$

s.t.

1- $\frac{dE[U_B]}{de_1} = 0$

2- $\frac{dE[U_B]}{d\theta} = -\psi'(e_2(\theta))$

3- $E[I(e_1)t_1 + t_2(\theta^h) - \psi(e_1) - \psi(e_2(\theta^h))] \geq 0$

From the incentive compatibility constraint related to the first phase of the project we obtain $t_1 = \psi'(e_1)$. Substituting in the participation constraint we get the following ex ante utility: $E[U_B] = e_1\psi'(e_1) + t_2(\theta^h) - \psi(e_1) + \psi(e_2(\theta^h)) = 0$. Given that the government aims at the agent's rent extraction and considering that the consortium is not protected by a limited liability constraint, the principal can set the second period transfer equal to $t_2(\theta^h) = \psi(e_1) + \psi(e_2(\theta^h)) - e_1\psi'(e_1)$. As a consequence, the participation constraint is ex ante binding for the least efficient operator, while the private incentive compatibility constraints remain effective. The obtained government's welfare function is defined as follows:

$$\underset{e_1,e_2(\theta)}{max} W_B = \int_{\theta^l}^{\theta^h} \{S_0 + e_1S - (1+\lambda)[\psi(e_1) + \psi(e_2(\theta)) + O - e_1\theta - e_2(\theta)]$$
$$-\lambda[\tfrac{F(\theta)}{f(\theta)}\psi''(e_2(\theta))]\}f(\theta)d\theta$$

Optimizing w.r.t. $e_1$and $e_2(\theta)$ yelds respectively

$\psi'(e_1^B) + \lambda\frac{dT_B^*}{de_1} = S + (1+\lambda)\theta$

where $\frac{dT_B^*}{de_1} = \psi'(e_1^B)$

$\psi'(e_2^B(\theta)) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\theta)}{f(\theta)}\psi''(e_2^B(\theta))$

4 - Welfare Analysis

The expected function that is used to perform the comparative statics analysis is the following one:

$\int_{\theta^l}^{\theta^h}\{S_0 + e_1 S - (1+\lambda)[e_1 t_1 + t_2(\theta) + O - e_1\theta - e_2(\theta)]$

$+(e_1 t_1 - \psi(e_1)) + (t_2(\theta) - \psi(e_2(\theta))\}f(\theta)d\theta$

Using the new effort functions the first order conditions in the bundling case become:

$e_1^B = \frac{S+(1+\lambda)\theta}{1+\lambda}$

$e_2^B(\theta) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\theta)}{f(\theta)}$

Substituting in the government objective formula we obtain the value function under bundling:

$V_B = \int_{\underline{\theta}}^{\overline{\theta}}\{S_0 + Se_1^B - (1+\lambda)[\frac{(e_1^B)^2}{2} + \frac{(e_2^B)^2}{2} + O - e_1^B\theta - e_2^B(\theta)]$

$\quad -\lambda[\frac{F(\theta)}{f(\theta)}\psi''(e_2(\theta))]\}f(\theta)d\theta$

Differences between the two scenarios come from the builder's effort; hence the analysis is developed using only factors dependent on e_1^B

$V_B = \int_{\underline{\theta}}^{\overline{\theta}}\{\frac{S^2}{1+\lambda} + \theta S - (1+\lambda)[\frac{S^2}{2(1+\lambda)^2} + \frac{\theta^2}{2} + \frac{S\theta}{1+\lambda} - \frac{\theta S}{1+\lambda} - \theta^2]\}f(\theta)d\theta$

$V_B = \int_{\underline{\theta}}^{\overline{\theta}}\{\frac{S^2}{1+\lambda} + \theta S - (1+\lambda)[\frac{S^2}{2(1+\lambda)^2} - \frac{\theta^2}{2}]\}f(\theta)d\theta$

$V_B = \int_{\underline{\theta}}^{\overline{\theta}}\{\frac{S^2}{2(1+\lambda)} + \theta S + \frac{(1+\lambda)\theta^2}{2}\}f(\theta)d\theta$

$V_B = \frac{S^2}{2(1+\lambda)} + \bar{\theta}S + \frac{(1+\lambda)}{2}E[\theta^2]$

The new efforts functions applied to the unbundling case yelds respectively

$e_1^U = \frac{S+(1+\lambda)\bar{\theta}}{1+2\lambda}$

$e_2^U(\theta) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\theta)}{f(\theta)}$

Substituting in the government objective formula we obtain the value function under unbundling:

$$V_U = \int_{\underline{\theta}}^{\overline{\theta}} \{S_0 + Se_1^U - \frac{(e_1^U)^2}{2}(1+2\lambda) - (1+\lambda)[\frac{(e_2^U)^2}{2} + O - e_1^U\theta - e_2^U(\theta)] \\ -\lambda[\frac{F(\theta)}{f(\theta)}\psi''(e_2(\theta))]\} f(\theta)d\theta$$

Differences between the two scenarios come from the builder's effort; hence the analysis is developed using only factors dependent on e_1^U

$$V_U = \int_{\underline{\theta}}^{\overline{\theta}} \{\frac{S^2}{1+2\lambda} - \frac{S\overline{\theta}(1+\lambda)}{1+2\lambda} - (\frac{S^2}{2(1+2\lambda)} + \frac{(1+\lambda)\overline{\theta}S}{(1+2\lambda)} + \frac{\overline{\theta}^2(1+\lambda)^2}{2(1+2\lambda)}) \\ -(1+\lambda)[-\frac{\theta S}{1+2\lambda} - \frac{\theta\overline{\theta}(1+\lambda)}{1+2\lambda}]\} f(\theta)d\theta$$

$$V_U = \int_{\underline{\theta}}^{\overline{\theta}} \{\frac{S^2}{2(1+2\lambda)} + \frac{(1+\lambda)\theta S}{1+2\lambda} - \frac{\overline{\theta}^2(1+\lambda)^2}{2(1+2\lambda)} + \frac{\theta\overline{\theta}(1+\lambda)^2}{1+2\lambda}\} f(\theta)d\theta$$

$$V_U = \frac{S^2}{2(1+2\lambda)} + \frac{(1+\lambda)\overline{\theta}S}{1+2\lambda} + \frac{\overline{\theta}^2(1+\lambda)^2}{2(1+2\lambda)}$$

The net welfare gain of governments when using PPPs is equal to:

$$V_B - V_U = \frac{\lambda S^2}{2(1+\lambda)(1+2\lambda)} + \frac{\lambda\overline{\theta}S}{1+2\lambda} + \frac{(1+\lambda)}{2}\sigma_\theta^2 + \frac{\lambda(1+\lambda)}{2(1+2\lambda)}\overline{\theta}^2$$

$$V_B - V_U = \frac{\lambda}{2(1+\lambda)(1+2\lambda)}(S^2 + (1+\lambda)^2\overline{\theta}^2 + 2(1+\lambda)\overline{\theta}S) + \frac{(1+\lambda)}{2}\sigma_\theta^2$$

$$V_B - V_U = \frac{\lambda}{2(1+\lambda)(1+2\lambda)}(S + (1+\lambda)\overline{\theta})^2 + \frac{(1+\lambda)}{2}\sigma_\theta^2$$

A Robustness check: simultaneous contracts

Differences between the two scenarios come from the builder's effort; hence the analysis is developed using only factors dependent on e_1^S

$$V_U^S = \int_{\underline{\theta}}^{\overline{\theta}} \{\frac{S^2}{1+2\lambda} - \frac{S\theta(1+\lambda)}{1+2\lambda} - (\frac{S^2}{2(1+2\lambda)} + \frac{(1+\lambda)\theta S}{(1+2\lambda)} + \frac{\theta^2(1+\lambda)^2}{2(1+2\lambda)}) \\ -(1+\lambda)[-\frac{\theta S}{1+2\lambda} - \frac{\theta^2(1+\lambda)}{1+2\lambda}]\} f(\theta)d\theta$$

$$V_U^S = \int_{\underline{\theta}}^{\overline{\theta}} \{\frac{S^2}{2(1+2\lambda)} + \frac{(1+\lambda)\theta S}{1+2\lambda} - \frac{\theta^2(1+\lambda)^2}{2(1+2\lambda)} + \frac{\theta^2(1+\lambda)^2}{1+2\lambda}\} f(\theta)d\theta$$

$V_U^S = \frac{S^2}{2(1+2\lambda)} + \frac{(1+\lambda)\bar{\theta}S}{1+2\lambda} + \frac{(1+\lambda)^2}{2(1+2\lambda)}E[\theta^2]$

The net welfare gain of governments when using PPPs is equal to:

$V_B - V_U^S = \frac{\lambda S^2}{2(1+\lambda)(1+2\lambda)} + \frac{\lambda\bar{\theta}S}{1+2\lambda} + \frac{\lambda(1+\lambda)}{2(1+2\lambda)}E[\theta^2]$

$V_B - V_U^S = \frac{\lambda}{2(1+\lambda)(1+2\lambda)}(S^2 + (1+\lambda)^2\overline{\theta}^2 + 2(1+\lambda)\bar{\theta}S) + \frac{\lambda(1+\lambda)}{2(1+2\lambda)}\sigma_\theta^2$

$V_B - V_U^S = RS + \frac{\lambda}{(1+2\lambda)}IE$

5 - Comparative Statics Analysis

$RS = \frac{\lambda}{2(1+\lambda)(1+2\lambda)}(S + (1+\lambda)\overline{\theta})^2$

$\frac{dRS}{d\lambda} = (S + (1+\lambda)\overline{\theta})^2(\frac{2(1+\lambda)(1+2\lambda)-2(3+4\lambda)\lambda}{4(1+\lambda)^2(1+2\lambda)^2}) + \frac{\lambda}{2(1+\lambda)(1+2\lambda)}2\overline{\theta}(S + (1+\lambda)\overline{\theta})$

$\frac{dRS}{d\lambda} = (S + (1+\lambda)\overline{\theta})^2(\frac{2(1+3\lambda+2\lambda^2)-(6+8\lambda)\lambda}{4(1+\lambda)^2(1+2\lambda)^2}) + \frac{\lambda}{2(1+\lambda)(1+2\lambda)}2\overline{\theta}(S + (1+\lambda)\overline{\theta})$

$\frac{dRS}{d\lambda} = (S + (1+\lambda)\overline{\theta})^2(\frac{(1-2\lambda^2)}{2(1+\lambda)^2(1+2\lambda)^2}) + \frac{\lambda}{2(1+\lambda)(1+2\lambda)}2\overline{\theta}(S + (1+\lambda)\overline{\theta})$

- $(S + (1+\lambda)\overline{\theta})^2(\frac{(1-2\lambda^2)}{2(1+\lambda)^2(1+2\lambda)^2}) < 0$ if $\frac{1}{\sqrt{2}} \leq \lambda \leq 1$
- $\frac{\lambda}{2(1+\lambda)(1+2\lambda)}2\overline{\theta}(S + (1+\lambda)\overline{\theta}) < 0$ if $\overline{\theta} < 0$ (negative externality)

Comparative statics analysis of the RS effect with respect to $\overline{\theta}$

$RS = \frac{\lambda}{2(1+\lambda)(1+2\lambda)}(S + (1+\lambda)\overline{\theta})^2$

$\frac{dRS}{d\overline{\theta}} = \frac{\lambda^2}{2(1+\lambda)(1+2\lambda)}2(S + (1+\lambda)\overline{\theta})$

- $\frac{dRS}{d\overline{\theta}} > 0$ if $S > -(1+\lambda)\overline{\theta}$
- $\frac{dRS}{d\overline{\theta}} = 0$ if $S = -(1+\lambda)\overline{\theta}$

- $\frac{dRS}{d\overline{\theta}} < 0$ if $S < -(1+\lambda)\overline{\theta}$

Comparative statics analysis of the IE effect with respect to λ

$IE = \frac{(1+\lambda)}{2}\sigma_\theta^2$
$\frac{dIE}{d\lambda} = \frac{\sigma_\theta^2}{2} \geq 0$

Comparative statics analysis of the IE effect with respect to σ_θ^2

$IE = \frac{(1+\lambda)}{2}\sigma_\theta^2$
$\frac{dIE}{d\sigma_\theta^2} = \frac{(1+\lambda)}{2} \geq 0$

2 Public Private Partnerships from budget constraints: Looking for Debt Hiding?

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Abstract

In this paper, we examine whether budget constrained public authorities are more likely to use PPP (Public Private Partnership) than traditional procurement methods. Then, we study the possible mechanisms beyond this choice. Our empirical test focuses on France and consists of a two stage approach. Firstly, we look at the impact of budget constraints on the use of PFI (Project Finance Initiative) and we find a positive relationship. Secondly, to better disentangle the debt hiding effect, we exploit the 2011 change in the ability to underwrite PPP debts. We find that that debt hiding is a relevant, but not sufficient element for explaining the budget constrained governments'' attitudes towards PPPs.

2.1 Introduction

Over the past few years, governments' behaviors and policies have heen significantly affected by public finance constraints stemming from domestic policies, financial markets, or regulatory measures. One prominent example is the deficit and debt limits imposed by the European Union according to the terms of the 1992 Maastricht Treaty. As a consequence, available resources to pursue puhlic investment strategies have heen increasingly rationed, a process that in turn makes the efficient organizational structure crucial for the realization and management of public investment.

An alternative to the conventional provision of public infrastructures (traditional procurement) are fixed-price risk-transfer contracts, such as the the "Contrat de Partenariat" in France (thereafter PFI/CP)[1]. These contracts fall within the definition of public private partnerships (PPPs), i.e., contractual agreements allowing the involvement of the private sector's capital and expertise for the realization and management of an asset that will be returned to the public sector after an adequate period of time (the "bundling" mechanism after Hart, 2003).[2]

Our hypothesis builds on earlier literature examining the costs and benefits of PPP. First, theory underlines the use of these contracts can release public funds for alternative uses thanks to the introduction of private knowledge or financing and due to the stronger involvement of agents in the project (Auriol and Picard, 2013; Buso, 2014). Second and nevertheless, since PFI first emerged as a financing option, these contracts have been considered very costly in comparison to traditional procurements (TP) because of their higher financing costs and need to realize private projects. Furthermore, given the Eurostat rule of 2004 allowing public investments under PPPs to be accounted as being off the balance sheet,[3] these contractual organizations are often accused of being used specifically for debt hiding motivations (OECD, 2009; NAO, 2011; PwC, 2010), and thus their use can be related to political matters. In summary, the use of PFI can reflect motivations other than cost savings, and their use does not clearly emerge to fill the role created by increased the public budget constraints. However, few empirical studies explicitly address this topic (Russo and Zampino, 2010; Krumm and Mause, 2012).

Filling this gap, our analysis aims at improving understanding of the public finance implications of PPPs by answering the following questions: Are governments more tempted to use PPPs under budget constraints conditions? If so, what can explain this behavior? Hence, we first investigate the effect of governments budget constraints on the use of PPPs. We then examine whether or not the higher/lower propensity of investment in PPPs from financially distressed institutions results

[1]The first "Private Finance Initiative" was created in the UK in 1992, followed by the "Contrat de partenariat" in France in 2004, under the Ordonnace n°2004-559 of June 17, 2004, then improved by the French PPP Law of the July 28, 2008.

[2]All PPPs require an adequate transfer of risk from the public to the private partners. PFI/CPs are different than other types of PPPs, i.e. concessions, because of the risks transferred during the operational phase: availability risk under a PFI/CP, demand risk under a concession.

[3]From a legal perspective, PPPs (therefore PFI/CP) are classified off-balance sheet for governments, as the private partner bears both the construction risk and at least one of either availability or demand risk.

from a real saving/waste of public resources or a virtual withdrawal of costs from governments budgets (debt hiding)[4].

We shed light on these questions through an empirical analysis covering French municipalities. The French context offers an appealing case study for three reasons. First, we can investigate the totality of PFI/CP contracts[5] thanks to a collaboration with the French PPP taskforce sieged at the Ministry of Finances and Economy (thereafter MaPPP)[6]. Second, the French Ministry of Finances and Economy has made available a panel of financial budget information about municipalities.[7] Third, the municipality level has the majority of PFI/CP contracts among local public authorities (101/138).[8]

We compare our sample of municipalities, namely, those having at least one PFI/CP, with an adequate control group composed of municipalities with the same potential demand for long-term public investment. This allows us to analyze how budget constraints impact a government's choice of PFI/CP procedures. We then investigate the effect of the new decree classifying PFI/CP as on balance sheet since January 1, 2011.[9] This new accounting rule allows us to study the heterogeneity of the previous effect by looking at the change in sign and size of the impact when debt hiding motivations are ruled out. We find that a strict budget constraint is associated with a more frequent use of PFI/CP. The new rule negatively impacts both the use of PFI/CP and the level of investment, however, the effect of budget constraints still persist after 2011, especially when financial costs are considered. We then conclude that the use of PFI/CP is driven by restriction of financial resources, not merely for debt hiding motivations.

[4]Public investment decisions are taken at the local level, while public control of budget data is handle at national or European levels. As a consequence of this role distribution, local authorities are tempted to use PPPs to hide their financial conditions thanks to their stronger possibility to be accounted as off the balance sheet. In such a way, municipalities can elude external controls, thus releasing fictitious resources for further investments.

[5]All contracts taken out over the entire life-cycle are available.

[6]The Mission d'appui aux Partenariats public-privé (MaPPP) is the French Taskforce for PPPs. Its role consists of: assessing PPP projects, supporting the preparation and negotiation of procurement and contract documents, and promoting the PPP market in France.

[7]Financial information of all administrative levels is available at http://www.collectivites-locales.gouv.fr/

[8]It is particular interesting to focus on municipalities inasmuch as budget constraint concerns are known to increase in importance at the municipality level (Bel & Fageda 2009, JORF 2012)

[9]The decree enacted on December 16th 2010 required all PFI/CPs to be accounted on the balance sheet at the date of the infrastructure delivery. This new decree has applied since January 1st 2011 to both existing and new PFI/CPs.

The paper is organized as follows. Section 1 describes the related literature and derives testable hypotheses. Section 2 discusses the French institutional context and legal environment regulating PFI/CP contracts. Section 3 presents a description of the the data. Section 4 explains our empirical strategy and discusses the paper's results. Finally, Section 5 concludes.

2.2 Related literature and Hypotheses testing

The majority of existing theoretical papers study the welfare effects of the bundling mechanism employed by PPPs, i.e., the assignment of different phases of a project to a single private consortium (Martimort and Pouyet, 2008; Iossa and Martimort, 2008; Hart, 2003). However, the financial implications and determinants of PPPs have been less investigated. Related contributions have been made by Engel et al. (2010, 2013), Auriol and Picard (2013), and Buso (2014). They study the public finance implications of PPPs, focusing on analyzing how distortionary taxation[10] can affect the choice between PPP and TP. According to Engel et al. (2013), the higher shadow cost of public funds (λ)[11] is not a sufficient argument for preferring the private provision of services in a multiperiod context, as the resources saved by the government during the investment's early period are offset by giving up future revenue flows to the concessionaire. Converserly, Auriol and Picard (2013) find that this shadow cost λ becomes relevant in comparing the public regime with "build operate transfer" contracts (BOT)[12] for the realization and operation of a public facility. Their paper examines a different context with respect to Engel et al. (2013); their model assumes that the concession holder is allowed to operate under laissez-faire regime. Furthermore, the private principal faces much weaker information asymmetry with their own manager compared to the government. Despite following a different approach, Buso (2014) reaches a similar result. His theoretical model is built under the context of asymmetric information; however, the level of public service provision is set by the government both under TPs and PPPs. Within this framework, the saving of distortionary costs under PPPs comes from the long-term

[10]Costs imposed to taxpayers to collect funds for financing the investment.

[11]Opportunity cost from investing in this project instead of financing alternative public goods; it can be higher when the government's spending capacity is lower (budget constraints).

[12]BOT contracts are PPPs where the private partner is in charge of the building, operational, and financial tasks.

involvement of the private agent, which benefits the government in terms of reduced need for investment incentives.

Conversely, most empirical papers aim at detecting the economic and non economic factors able to explain private involvement in public services delivery (Bel and Fageda, 2009, 2010; McGuire et al., 1987; Miralles, 2009; Dubin and Navarro, 1988; Picazo-Tadeo et al., 2012). Starting from this strand of literature, few works focus on PPPs and their determinants (Hammami et al., 2006; Albalate et al., 2012; Russo and Zampino, 2010; Krumm and Mause, 2012). Hammami et al. (2006) provides a cross country analysis showing that PPPs are more frequent in countries characterized by large markets, high demand, and good institutions. Furthermore, past experience in PPPs as well as high government debts are important factors in explaining the selection of this investment option. Different from the previous study, Albalate et al. (2012) create an index that captures the degree of private participation in each contractual form with the purpose of testing the drivers of contract choice in agreements that correspond to different levels of private involvement. They examine several political and economic variables and find that the large private involvement is more likely in single projects than in network projects. Further elements that explain the degree of private participation are fiscal variables and the jurisdiction level of the debt-stress or tax burden. However, political variables do not appear significant in explaining contractual choices. Russo and Zampino (2010) and Krumm and Mause (2012) try to find evidence for correlations between PPP investment and municipal budget data. Their papers cover, respectively, the contexts of Italy and the UK. Both show strong positive relationships between the number of PPPs and negative local budgetary outcomes. one explanation for this result focuses on the public buyer's opportunistic behavior. However, the possibility (mentioned by Russo and Zampino, 2010) remains that PPPs can be used as useful adjuvant treatment in order to overcome deficit trouble.

The above mentioned empirical studies highlight a connection between government financial constraints and the organizational structure of public investments, but fail to provide a motivation that explains their results. Our paper adds to this literature in that we examine alternative channels that motivate French municipalities to use PFI/CP instead of TP when resources are scarce. In fact, using data about PFI/CP in the French municipality context, we aim at testing the following hypotheses:

First, we expect budget-constrained governments to choose structures able to release public funds.

- *H1: The use of PFI/CP is positively associated with public budget constraints.*

Second, we expect debt hiding as a possible, but not unique motivation able to explain the budget constraint effect.

- *H2: Without debt hiding reasons, the impact of budget constraints on the use of PFI/CP should decrease, but remain positive.*

The first hypothesis tests the results of Auriol and Picard (2013) and Buso (2014) versus Engel et al. (2013). The first contributions add to the theoretical framework a further source of asymmetric information in the form of private constraints[13] with respect to Engel et al. (2013). This additional element is found to be determinant in the comparative statics on the cost of public funds and it elucidates a positive link between public constraints and use of PPPs.

The second hypothesis begins with the assumption that alternative reasons motivate adoption of PPPs. We isolate debt hiding motivations in order to evaluate their relevance and the extent to which it explains the budget constraint effect. The more the accounting advantages are relevant, the more suitable Engel's model becomes to describe the data, while asymmetric information becomes less determinant in explaining the budget constraint impact.

2.3 Institutional details

In this Section, we first focus on describing of French municipalities' budget elaboration and control processes. Then, we analyze how the accounting rules of PFI/CP

[13]In Auriol & Picard (2013), ex ante asymmetric information exists. In Buso (2013), the result comes from the introduction of a further private limited liability constraint.

contracts can lead to debt hiding behaviors. Finally, we present the new accounting rule in operation since 2011, which could limit this opportunistic motivation for using PFI/CP.

2.3.1 French municipalities' budgets

France has 36,000 municipalities, which are called "communes." They represent the fifth administrative level in France. Each has a mayor and a municipal council who jointly manage the area'a administration, and each set have exactly the same powers (no matter the commune's size). In terms of investment, they are in charge of pre-primary and primary schools, libraries, cultural and sport centers, and urban equipments. The principle of municipal self-government leaves much freedom to the municipality to take responsibility for its own investments, organization, and financing. However, their budgets are constrained as they have to achieve a balanced public account, for both investment and operations sections.

Following the General Code for Local Authorities,[14] municipalities are obliged to specify annualy their balanced budget for the coming year, which should contain a plan for balancing their investment and the operating budgets. Operating revenue is mainly composed of local taxes and government grants. Operating expenses are those related to municipality's on-going operation: staff salaries, infrastructure maintenance costs, expenses related to the municipality missions, financial costs of existing debt. Investment revenue comes from several sources. Operating budget surpluses provide the majority of the investment budget (42% in 2012). Government transfers and grants represent 24%, duties 10%, and finally, local taxes and loans represent the remaining 24%.[15] Investment expenses cover payment of annual debt service, as well as new investment in infrastructure. It is important to emphasize that France has a "golden rule" regarding the public budget: public authorities can borrow only to invest and not to fund current spending.

As enacted in the Consitution in 2008, public accounts are required to be balanced as a multiannual objective. This objective is controlled by two levels: the Administrative Courts and the Regional Court of Accounts (Chambre régional des Comptes).

[14] France's General Code for Local Authorities (Code général des collectivités territoriales - CGCT) includes laws and regulations applied to local authorities' three main levels: municipality, department and region.

[15] Data come from the Ministry of the Interior: http://www.collectivites-locales.gouv.fr/files/files/OFL_2013%282%29.pdf

The first control includes the Prefect's supervision over the effective balance of municipalities' accounts, as well as the possibility of administrative courts to take actions against a Mayor's misuse of power. The second instrument aims at checking both the ex ante achievement of the balanced budget requirement and ex post excessive deficits with respect to the balanced budget targets (5-10%[16]). However, control procedures normally takes the form of support rather than sanctions.

In such a context, heavily indebted municipalities have higher levels of budget constraints upon their ability to achieve their infrastructures investment strategies[17] (JORF, 2012). In fact, existing debt is a burden for municipalities' operating and investment budgets: high levels of existing debt push up financial costs (which are part of operating expenses) and annual debt service (which are part of investment expenses). As a consequence, these municipalities can only achieve the same level of investment as other municipalities by taking larger and more costly loans from commercial banks.

2.3.2 Public Private Partnership and Debt Hiding motivations

Within this context, given that PFI/CP (and PPPs in general) could be accounted as off balance sheet following the Eurostat decision in 2004, they seemed to offer a possible solution to circumvent budget constraints. The Eurostat rule classifies infrastructure realized through PPP as non-governmental through the "risks and rewards" criterion. Following this guidance, public authorities have accounted PFI/CP as off balance sheet when the construction risk and at least one of either availability or demand risk are transferred to the private operator. In such a manner, PFI/CP was accounted for the public balance-sheet based on the logic of accrual accounting: the annual payment related to the investment, financial and operating costs was reflected in the public account; the remaining element was accounted as a multiannual plan of payment in an appendix to the balance-sheet. As a consequence, debt corresponding to PFI/CP did not appear on the public account.

This accounting rule might increase incentives in favor of PFI/CP procedures for other reasons than the to-be-achieved target of value for money. The first level is the budgetary level. As discussed in the Section 2.1, PFI/CP can enable public

[16] 10% for municipalities with a population that is less than 20,000 citizens, 5% otherwise

[17] The Report of the Journal Officiel de la République Française stated that the level of public investment in France had slowed down in the 1990s due to a hard budget constraint and a high level of public debt (JORF 2012).

authorities who do not have a sufficient capital budget to still achieve their desired capital investment strategy. In fact, while a traditionally procured capital project presents a significant immediate hit to the municipality's capital budget, PFI/CP will have a smaller (but much longer lasting) impact. Second, the French target, in place since 2005 to reduce Public Sector Net Debt from 66% of GDP to under 60% could provide an incentive to favor PFI/CP over spending funded directly by government borrowing. This reflects the fact that in the short term, a PFI/CP scheme would result in reduced government borrowing and therefore a lower level of Public Sector Net Debt. Third, the European level requirement, i.e., the Maastricht Treaty, obliges member states to avoid excessive budgetary deficits. More precisely, it set out that governments' annual deficit and debt should not exceed: (a) 3% for the ratio of planned or actual government deficit to gross domestic product at market prices and (b) 60% for the ratio of government debt to gross domestic product at market prices.[18] These European fiscal rules therefore both incentivize the use of investment methods permitting off balance sheet financing rather than direct capital spending funded through government borrowing.

As stated by the House of Commons (2011): "given the salience of the public debt statistics in the current political climate, the attractiveness of the PFI method for any government has been evident whether it provides value for money of not." This trend has been reported not only for the UK, but also for other European countries such as Greece, Spain, Portugal, and Ireland[19].

At the end of 2010, the French Government decided to create a Decree on the topic of PFI/CP accounting rules. This Decree requires that PFI/CP commitments at the local level are no longer recognized off the balance sheet, for both existing and new projects. Two reasons motivated this clarification of PFI/CP accounting. First, in the UK, where the PPP experience is most advanced, the Government committed to providing more transparency to PFI/CP. In fact, the Office for Budget Responsibility decided to include an assessment of the impact of the PFI/CP liabilities in their fiscal sustainability report, a break with previous years' National Accounts (UK House of Common, 2011). Second, the application of the International Financial Reporting

[18] Official Journal of the European Union, Protocol on the Excessive Deficit Procedure, Article 1, December 16, 2004

[19] The Financial Times reported that in 2002, Goldman Sachs helped Greece raise off-balance sheet finance "by arranging a massive swaps transaction aimed at reducing the cost of financing." The press report explained: Because it was treated as a currency trade rather than a loan, it helped Greece to meet European Union deficit limits while pushing repayments far into the future (Financial Times, Athenian arrangers, February 17, 2010, p7).

Standards (thereafter IFRS) implied a switch from the "risks and rewards" criterion to the control criteria. More precisely, under a PFI/CP, if the public authority controls one of the following five aspects of the project, the corresponding debt should be accounted as on balance-sheet: (a) the private operator is not able to sell or take a loan on the equipment. (b) the occupation of the public owned domain. (c) the definition of the equipment's main features. (d) the public service's management. (e) the revenue paid to the private operator for his service. This new rule has led to recognition on the balance sheet of the asset and corresponding debt upon the infrastructure's delivery. In other words, the balance-sheet records the investment's capital value as an asset, while the already-paid investment and the remaining debt are recorded as liabilities. For both these reasons, we can argue that the rule is not affected by either PFI/CP's supporters or detractors. The new regulation's implementation ensures greater transparency regarding the governemental body's real financial situation and might significantly reduce the temptation to choose PPPs to hide debt (Dupas et al., 2012).

2.4 Data description

2.4.1 PFI/CP database

Our data are collected in collaboration with the French Ministry of Finances and Economy. Data for PFI/CP contracts are collected with the MaPPP department. Information regarding investment amount, year of signature, and the contract sector have been coded. Among the total of 138 local PFI/CP that have been signed between their creation in 2004 and August 2013, 101 are at the municipal level. Both very small and very big municipalities have used these measures; the smallest municipality has 2,500 inhabitants, while the biggest has 847,000 inhabitants. They invest an average of 25 million euros each year and are heavily indebted. Their debt represents on average 89.7% of the budget, while the national average is 77%. Their annual debt payment represents an average of 12% of the budget. The mayors of these municipalities can be either right-wing (52%) or left-wing (38%).

Figure 2.1: Number of PFI/CP per year by sector

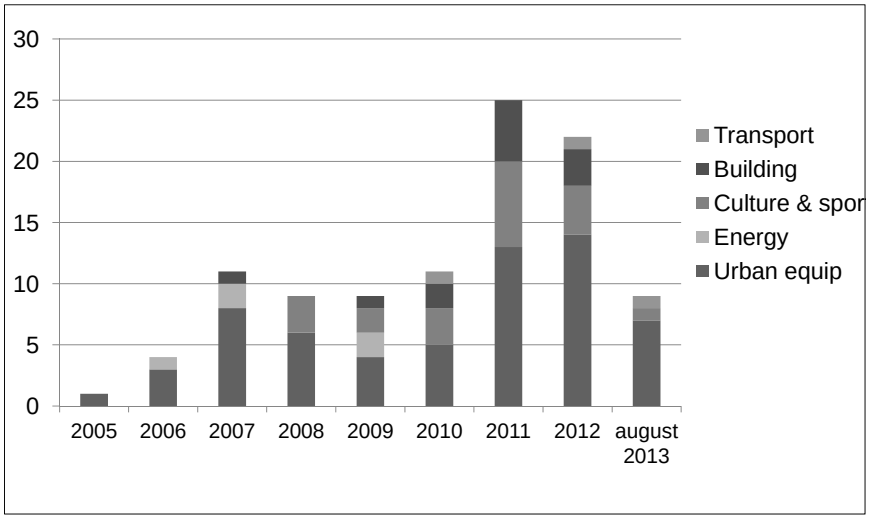
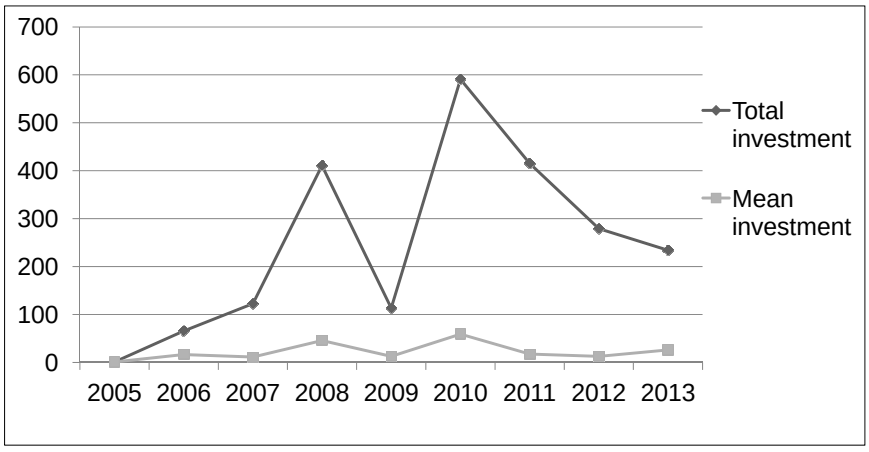


Figure 2.2: PFI/CP investment per year at the municipal level (millions of euros)



Figures 2 and 3 describe these municipalities' investments in PFI/CPs. Municipalities mainly use PFI/CP in the public equipment and culture & sport equipment sectors.[20] Other sectors are waste treatment/energy and construction[21] (Figure 1). In terms of number of concluded PFI/CPs, we observe a slow adoption by French municipalities of this new type of contract. Created in 2004, PFI/CPs only became popular in 2007, with 13 signed contracts at the municipal level. This trend can be explained by a multistep procedure before the conclusion of a PFI/CP (Saussier

[20]Public equipments under PFI/CP are mostly public lighting projects. Culture and sport equipments mainly consist of stadiums and theaters.

[21]The building sector includes schools and administration buildings

and Tran, 2012). Since then, we can observe an increasing number of PFI/CP per year until 2011; thereafter, while the number of total contracts remains significant, the trend turns negative (Figure 1). Our sample includes 55 contracts before 2011 and 56 after 2011 (Figure 1). In terms of amounts invested in PFI/CP, even if the total investment amount per year decreased after 2010, the average per contract remains fairly stable (Figure 2). It is also worth mentioning that six municipalities have more than one PFI/CP.

2.4.2 Control group

Municipalities that invest through PPPs share similar characteristics that differentiate them from other municipalities. To deal with this problem of self selection, we create a control group of French municipalities (approximately 36000 observations) that have possibly selected alternative investment options, e.g., Traditional Procurements. This strategy allows us to take into account the selection bias to assess our effect of interest.

With the aim of performing a suitable comparison, we choose a matching strategy that allows us to create a control group as similar as possible to our treatment group in terms of observable characteristics. The use of the matching strategy as choice-based sampling designs is already discussed in the literature (Rosenbaum and Rubin, 1985; Rubin and Thomas, 2000; Abadie et al., 2007; Heckman and Todd, 2009) and is frequently chosen in evaluation studies to reduce costs of data collection in situations where the potential control population is much larger than the treatment sample.

The matching variables for our treatment group of municipalities having at least one PFI/CP are furnished by the National Institute of Statistics and Economic Studies (INSEE). We matched municipalities in terms of their need for public investments (population features). This strategy is coherent with our research analysis inasmuch as we would like to test the impact of local institutional features (supply side) upon selection of PFI/CP among municipalities with the same potential demand for these types of investments. We captured the potential local request for PPPs through several variables covering the years 2009, 2010, and 2011 that reflect: population size, area, number of households, total income, total tax revenues, number of workers, number of unemployed people, population age distribution, number of firms in different sectors, number of public firms and the number of SMEs (Small and Medium

Enterprises).

The implemented procedure requires several steps. First, we estimated the propensity score using a logistic regression and a nearest neighbors estimation; our dependent variable is a dummy describing whether or not a municipality has undertaken a PFI/CP investment, while the covariates are the selected matching variables.[22] Second, we chose the two nearest neighbor observations in terms of propensity score for each municipality in our PFI/CP group. In case a municipality has made more than one PFI/CP investment, we select two control collectivities for each investment made.

At the end of this step, we obtain a sample of 297 municipalities in which 95 come from our initial database, with the remaining ones comprising our control group. The dataset used for the matching strategy is the largest among those made available by the INSEE. We further use similar variables, still furnished by INSEE, related to the period 2000 to 2009 to assess whether or not our two groups are similar over time. Tables 1 and 2 in the appendix report the ps test showing the similarity of our two groups during our period of study.

2.4.3 The panel database

We merged our initial database furnished by the MaPPP with our selected control group. The resulting database allows us to compute the effect of budget variables on the use of PFI/CP instead of other contractual typologies. Our strategy is based on the assumption that any observable and unobservable differences in terms of investment demand between the two groups can be ruled out by performing the empirical strategy only over effectively comparable observations.[23] As a second step, we gathered a panel of control data describing the supply side (municipalities' features) from the website of the French Ministry of Finances and Economy.[24]

Data regards the main budget and are divided in two sections: the first is about functioning operations, the second concerns investment commitments. For each municipality we collect the yearly financial dimensions for the period going from

[22] We report the pstest that controls for the correct achievement of the matching strategy in Table 1 (Appendix)

[23] This assumption can seem extremely strong for a very heterogenous sample, but it is plausible for the French system, which is characterized by a quite homogenous market and institutional framework.

[24] http://www.collectivites-locales.gouv.fr

2003 to 2012. We select covariates from both sections that reflect the investment plan as well as the budget results and the financial situation.

In this database, municipalities are organized in 30 "reference groups" that are created by taking into account: population size, participation in public establishment of inter-municipal cooperation, and any additional tax systems adopted by the inter-municipal institution. Public accounts provide, for each financial variable, the average value of the municipality reference group. Thanks to this information, data can be relativized, and we can compare different municipalities over time.[25]

Table 3 in the appendix gives the main budget characteristics of our dataset's two groups: group "PFI/CP" with 95 observations and group "No PFI/CP" with 202 observations. All variables are defined as means over the period 2003−2012. The level of investment in PFI/CP is on average 32.3 million euros for the first group, and 0 for the second. The first group of collectives shows a lower level of subventions from the central level. Furthermore, they report lower levels of financial and accounting budget results. Municipalities in the first group are more indebted than those in the second group. Total debt in is approximately 63.6 million euros for the first group, but only 45.2 million euros for the second. The share of debt per capita is also higher for the group "PFI/CP" (137% versus 112%). Conversely, we observe a higher level of investment in all types of contractual agreements for the second group (29.9 million euros versus 26.6 for the group "PFI/CP"). We conclude that municipalities in the group "No PFI/CP" have their own investment strategies, but did not choose PFI/CP as contractual agreements.

2.4.4 Empirical Variables

In this subsection, we highlight the variables we selected to investigate the effect of budget constraints on PFI/CP investment and after the response following the 2011 introduction of the new rule. We use a panel database covering the period 2003 to 2013. Thus, all variables are defined for each municipality i and each year t. The variables' descriptions with the expected signs are reported in Table 4 in the Appendix.

[25] In the analysis, all variables are considered as differences from the average of the reference group. When gross variables are considered, results are not affected.

Dependent variables

As previously discussed, we are interested in explaining the use of PFI/CP by French municipalities. We first introduce $pfi-choice_{it}$, a variable equal to 1 if municipality i in year t has already implemented a PFI/CP contract and 0 otherwise.

Explanatory variables

The level of each municipality's budget constraint is measured by its level of debt or by its capacity of self financing. Data concerns time $t-1$ with respect to the year of the dependent variables. This choice is consistent with the idea of capturing ex ante budget constraints and avoids problems of simultaneity. The proxies we use for the analysis are

- $debt_{it-1}$: debt in euros at time $t-1$. This proxy allows us to take into account the municipality's ex ante financial situation.
- $annuity_{it-1}$: installment debt at $t-1$. This proxy represents the sum of debt interest, which are also functioning costs, and debt capital repayments, which are also investment costs. It captures the municipality's annual debt expenses.
- $net-CAF_{it-1}$: self financing capacity at $t-1$. This is the municipality's surplus obtained from the functioning section. Net of the borrowings' capital repayments, these resources can be used for financing new investment. The higher the net CAF, the more resources are available and the less strict a budget constraint the municipality faces.
- $debt-change_{it-1}$: debt change at $t-1$. This variable reports the accounting difference between debt subscribed at $t-1$ and debt subscribed at $t-2$. This proxy fails to capture as much the ex ante level of debt, but rather shows the trends that characterized the past year.

The first measure is a stock variables that capture the municipality's ex ante exogenous situation, while the last three measures are flow variables that describe how the municipality's conditions change during the period preceding the investment's start.

Debt hiding reasons for engaging in PFI/CP in France were ruled out in 2011. We take into account this legal discontinuity by introducing the variable $rule_t$, which is equals 1 for periods of time preceding 1st January 2011 and 0 otherwise.

Control variables

Given that we have a panel database and are comparing similar municipalities in terms of population features, we select those financial covariates that vary over time and could influence both the dependent variable and budget constraint proxy. We consider financial variables that reflect municipalities' capacity to deal with both the investment's demand and the balanced budget requirements.

We first include: $current{-}result_{it-1}$ which is the difference between current revenues and current costs of municipality i at $t-1$, and $overall - result_{it-1}$ which is the difference between the current result and the outcome of the investment section of municipality i at $t-1$. These variables control for the balancing of the operating and the investment budgets as required by the balanced budget specifications.

Then, we consider: $investment_{it-1}$ which captures the total level of investment of municipality i at $t-1$, and $subventions_{it-1}$ which reflects the level of national support the municipality received for its investment plans at $t-1$. These variables are derived from the investment section and control for both size of the investment plan and level of ex ante available resources.

2.5 Empirical strategies

We have available a panel database of municipalities that we use to test alternative reasons for pursuing PFI/CP contracts, focusing on the role of budget constraints. In the following section, we propose a duration analysis for exploring the determinants of the time until a municipality decides to utilize a PFI/CP contract. Thanks to this technique, we are able to explore the factors behind a municipality's decision to invest or wait in the period following 2004, when the new investment procedure was introduced to the legal system. The following section is organized as follows. First, we describe the duration analysis and we report the main results. Second, we perform robustness checks to reinforce the validity of our empirical strategy.

Finally, we propose an interpretation of our results by providing a comparison with the theoretical literature previously discussed.

2.5.1 Duration analysis

Duration or survival analysis is an empirical technique for which time is the outcome variable of interest. More precisely, the dependent variable is defined as survival time because it provides the interval until a certain event (failure) occurs. The terminology suggests the main application areas are health and financial economics. However, this approach can be applied to any type of event that affects individuals in different moments. Our research question is a suitable application of the duration analysis inasmuch as more municipalities have invested in PPPs over the period 2005 to 2013. In our case, the investment action represents the event (failure), while the survival time is given by the number of years until the investment takes place. In such an analysis, we use the entire database composed of our treatment and control groups. Thus, the time is right censoring for all municipalities that do not experience the event prior to 2013.

Within this approach, two concepts must be introduced: the survivor function and the hazard function. The first, $S(t)$, gives the probability that an individual (or municipality) will survive longer than time t. The hazard function provides the instantaneous probability that investment (failure) will occur per unit of time. This technique enables us to first, estimate and interpret the survivor function; second, compare survivor and hazard functions; and third, assess the relationship between explanatory variables and survival time. This approach allows us to identify the factors that determines the probability to implement PPPs and how the new rule affected this propensity to invest.

The introductory step of the survival analysis consists of the computation of the Klapan-Meier survival curve and the Hazard rate function, $h(t)$. The first is computed year by year and reports the proportion of municipalities that survive (do not invest) over time. The second gives the instantaneous potential per unit time for the event to occur given the survival up to time t. The graphs are as follows.

The first graph looks like a step function given the discrete time. Prior to 2005, the survival probability equals 1, after which some municipalities started to invest. At the end of the time period, the probability of investment is approximately 70%. This result reflects the composition of our dataset, which comprises 95 municipalities that invested in PFI/CP contracts and 202 control municipalities that did not implement any PFI/CP. The hazard rate function highlights the increasing conditional probability to invest in PPPs up to year 2011. Subsequently, after the application of the new accounting rule, the line shows a downward trend.

Our main goal is to assess the relationship between explanatory variables and survival time. We first approach the problem through a semi-parametric method, the Cox proportional hazard model. This model makes a main assumption that the hazard is proportional to the covariates (PH assumption). Thus, the effect of the budget covariates on the survival risk is assumed to mainly depend on one measurement. We perform a statistical test (stphtest) to assess the PH assumption. We implement a PH global test that controls for all covariates simultaneously. Furthermore, we graphically test the PH assumption for the budget constraint regressors (Table n. 6 appendix). Results of the proportional Cox model for the four budget proxies are reported in Table n. 5 in the appendix.

We add the budget covariates to the regressions to test which element provides the financial constraint effect by controlling for level of municipality investment, budget results and level of subventions received from the government. These variables are able to capture a municipality's propensity to invest as well as its level of available resources to meet the balanced budget requirements. The coefficients are negative, except for that indicating the overall budget, but none are significant. In addition to the budget covariates, we include the following in the regressions: three variables

already used for the matching strategy that reflect population features (population, income, and number of firms), and an institutional proxy (EQI), which is the European Quality of Government Index at the regional level (Charron, Lapuente et al. 2012).[26]. The matching covariates are used as a robustness check to further capture differences among municipalities related to the demand side. None of these were found to be significant. The EQI index controls for the municipality's institutional aspect; its coefficient is positive, but was not found to be significant.

More important for our analysis, however, is the effect of budget constraint proxies. When we use debt and the annuity, we find positive and significant effects that continue to persist after 2011.[27] While the rule was found to have a negative effect, this was never significant. The rule becomes relevant for the last two proxies, namely net CAF and the level of debt change in $t-1$. The first was introduced to assess whether or not the presence of municipality resources affects the propensity to implement PFI/CP contracts for a given level of debt. Before 2011, the effect was not significant, whereas after the new accounting law, the effect becomes highly positive and significant (a 7.48% increase in the probability that the investment will occur). This change can capture shifts in municipalities' behavior. Before 2011, for a given level of debt, the availability of resources for further investment did not affect the propensity to implement PPPs. After the introduction of the rule, a municipality showed a higher tendency to use PPPs when its budget is balanced and it can use such a measure to create new investment resources. The last proxy captures the increase or decrease of debt that occurred at time $t-1$. Its effect was not significant either before or after the application of the rule. However, the coefficient of the interrelation between the budget constraint proxy and the rule is negative and significant. Hence, municipalities with a high debt ncrease were less likely to implement PPPs after the introduction of the 2011 legislation. Looking at the global test, we can argue that the PH assumption is not violated in the implemented models. We further control for whether or not the budget constraint proxies separately respect the PH assumption. From graphs reported in Table n. 6, we can observe how fitted curves appear horizontal, which means that the scaled Schoenfeld residuals are independent with respect to survival time.

[26]This index is the combination of the level of corruption, protection of the rule of law, government effectiveness, and accountability at regional levels in the 27 EU Member States. The measures are collected in 172 EU regions, based on a survey of 34 000 residents across 18 countries (Charron, Lapuente et al. 2012).

[27]Effects after 2011 are reported through the post 2011 statistic.

The strategy's next step consists of implementing a full parametric model where survival time is assumed to follow a known distribution. We assume the most common Weibull distribution, which is a general distribution based on two parameters that can be reduced to an exponential distribution if the hazard is assumed to be constant over time. We run a parametric model for each proxy of the budget constraint. Results are reported in table n. 7 in the appendix.

Outcomes of these regressions are substantially equal to the ones of the Cox proportional Hazard model. Levels of debt or annuity increase the probability of investment in PFI/CP contracts. These effects do not change with the rule's application, and the coefficients remain positive and significant after 2011. Conversely, the rule seems more effective when the net CAF and debt-change proxies are used. In the first case, this highlights how the presence of internal resources became a significant argument in favor of PFI/CP investment, essentially after 2011. In the second case, the results determine the rule's impact on a proxy that reflects the municipality's yearly budget constraint. A graphical method for checking the validity of the Weibull distribution is provided by examining the Klapan-Meier log curves against log survival time. The graph reports a straight line; thus providing evidence that the distribution of survival times follows a Weibull distribution.

2.5.2 Robustness checks

To validate our empirical strategy, we first perform several robustness checks related to the previous regressions. As a second step, we propose alternative strategies to answer our research question and compare the resulting outcomes with the ones derived from the duration analysis.

The first robustness check concerns our matching strategy. We have already shown how the treatment and control municipality groups are similar not only with respect to the matching variables, but also by controlling for population characteristics related to the 2000 to 2009 time period. We include, as an additional test, all matching variables in our duration regressions. Results are not substantially affected. A further source of uncertainty remains in the interpretation of the interaction term between the accounting rule and the budget constraint proxy. In fact, the policy's impact can be anticipated or identified with hindsight by public buyers. We control,

using different thresholds,[28] if the rule shows noticeable impacts in either previous or following years, but did not find this to be the case. Furthermore, external factors could exist that influence the trend of the budget constraint proxy that are also correlated with the PFI/CP dependent variables. An example would be a financial crisis that could make PFI/CP investment more costly for the public buyer, especially when the latter is constrained in terms of total available resources (Marty and Tran, 2013). This effect should overemphasize the rule's potential impact, therefore we would be potentially overestimating the size of the debt hiding motivations and underestimating the relevance of alternative channels.

As a second step, we propose an alternative empirical strategy in order to check whether or not our results depend on the adopted specification. We choose to implement a panel strategy with a nonlinear model, where the dependent variable is a dummy that equals 1 if municipality i invests in PFI/CP contracts during year t. Applying a fixed-effect estimation with a nonlinear model can be problematic. In fact, first differencing or using within a transformation does not permit elimination of unobserved heterogeneity. Moreover, attempts to add municipality or time dummy variables to the logit or probit estimations will result in biased estimators due to the incidental parameters problem unless the time period is very large. A possible solution to this problem may come from using the traditional Random Effect Probit. This strategy is appealing, but assumes that the unobserved components are strictly exogenous and thus independent from our covariates. An alternative approach would be the Mundlack estimation, which assumes an explicit function for the latent variable. This method allows correlation between the random effect and regressors and permits the marginal effects to be calculated. It can be applied to our full sample and consists of computing a random effect logit or probit estimation including the average value over time for each of our regressor municipalities. In this paper, we first estimate the logit random effect. Results are reported in Table n. 8. Subsequently, we implement the Mundlack approach. Results are reported in Table n. 9.[29] The results in the first table (table n. 8) do not substantially change with respect to the duration analysis. As in the previous regressions, budget constraint effects are relevant both before and after the rule's application. The new accounting law affects the impact of the net CAF proxy as well as the relevance of the new debt taken out at time $t-1$. When the Mundlack approach is followed, results are

[28] We control for every year and only found nonsignificant impacts.
[29] Tables report directly marginal effects.

slightly different when debt and the debt change proxy are used. In the first case, the debt coefficient is positive and significant before the application of the rule, but is not significant after 2011. When the debt change proxy is used, the results are not significant. Thus, using this specification, we find that the rule directly impacts the stock of debt, and not only its short term change. The debt annuity (yearly debt costs) continues to have a positive and significant impact after the rule's application.

2.5.3 Economic interpretation

The initial goal of this paper was the test our hypotheses regarding the impact of public budget constraints on organization's investment choices. Following our empirical analysis, we can state that a government's choice of implementing a PFI/CP is affected by its level of financial stress; furthermore, this impact cannot be exclusively explained by the accounting advantages that normally characterize PFI/CP projects. We therefore turn the discussion to examining the reasons that make budget-constrained governments more inclined towards PFI/CP contracts. Apart from the debt hiding motivations, alternative channels are suggested by the literature or are discussed at a practical level; i.e.,

- First, governments can face temporary liquidity constraints (Engel et al., 2013). In such a case, the upfront spending required by TP can become more expensive than the future transfers required by PPPs (the distortionary cost of taxation is higher now than in the future). This benefit holds unless the planner can decide to optimally postpone the project (Engel et al., 2013) or TP repayment systems can be delayed by mimicking the timing allowed under PPPs.[30]
- Second, the introduction of asymmetric information can affect the choice of PPP or TP by giving relevance to the shadow cost of public funds. In fact, through PPPs, governments can entrust the investment decision to better informed agents (Auriol and Picard, 2013) or save incentive rents thanks to the private agent's long-term involvement (Buso, 2014).
- Next, alternative political channels resulting from relaxing the assumptions of perfect benevolent governments can help to explain our results (Maskin &

[30]It is also important to highlight how high levels of public debt do not directly imply government liquidity constraints.

Tirole 2008).

- Finally, even after introduction of the 2011 rule, debt hiding motivations could persist. This explanation should not be so relevant given the effectiveness of the French ordinance in ruling out accounting advantages (see institutional discussion).

With regard to our initial hypotheses, we can argue that the answer to the first research question is solved in favor of the arguments proposed by Auriol & Picard (2013) and Buso (2014); by contrast, the irrelevance theorem of Engel et al. (2013) does not fit our data. Conversely, we cannot uphold the statement that new accounting rule has been completely effective, nevertheless it is relevant for explaining some results. In fact, when the legislation was applied, the overall trend of investment in PFI/CP contracts significantly decreased. Moreover, the rule partially changed the relevance of budget constraints in explaining the propensity to invest through PFI/CP contracts. This is evident when net CAF and debt change proxies were used. The first proxy reflects the municipality's capability to finance PFI/CP investment with its own resources for a given debt level. The rule's application changed the reasons behind the municipality's investment choice: before, the presence of internal resources was not a determinant of PFI/CP investment; after the application of the rule, however, a strict relation between the investment and the balance accounts was created, making a municipality's investment decision directly affected by the balanced budget requirements. The debt change variable confirms the rule's significant and negative impact on the budget constraint's effect. This channel is evident when a short term debt proxy is used, but is not as important when debt stock is taken into account. However, it is plausible that what we capture in terms of the rule's effect on yearly debt should prompt decreases in the following years of the long run budget constraints' relevance.

Our results did not yield a perfect accord with the theoretical literature. In fact, our outcomes are best understood by developing a theoretical framework to study the role of both public and private budget constraints in a context of asymmetric information and financial uncertainty. Moreover, this approach should be developed together with a study of the political channels that can both explain the propensity to invest through PPPs and be correlated with the municipality's financial situation.

2.6 Conclusion

In this paper, we studied whether or not a public authority burdened by a hard budget constraint is more likely to choose PFI/CP; thereafter, we examine the nature of this effect, i.e., is it only for debt hiding? We find that a budget constraint is associated with higher use of PFI/CP. However, while the new accounting rule in 2011 might significantly change the temptation for municipalities to hide debt and consequentially decrease the impact of financial pressure on employing a PFI/CP investment, the budget constraint effect continues to be positive and significant for some debt proxies. We therefore conclude that debt hiding is not the only motivation when financially stressed municipalities choose PFI/CP investments.

Our empirical result contributes to the literature inasmuch as it does not merely detect the effect of budget constraints, but looks at possible motivations that induce constrained public authorities to choose PPPs; we ultimately discover that debt hiding reasons are important but are not the only relevant factors. This paper is, to the best of our knowledge, the first direct empirical analysis on this topic.

From a practical point of view, the paper can partially explain why countries have increasingly turned to PPPs in recent years. In fact, a 2009 OECD report stated that PPPs had grown to comprise a portion, although not the majority, of capital budgets in several countries.[31] This evolution experienced a temporary decline during the current economic crisis (EPEC 2011), however, the long term trend is expected to be positive (Wagenvoort et al., 2010). Our research addresses a very relevant problem in the current situation where resources are scarce and much creativity is needed to incentivize economic growth. Several extensions are possible and further research is welcomed on the topic.

[31] The United Kingdom has had the longest experience, with PPPs currently comprising from 10% to 15% of the capital budget in recent years. France and Korea have had similar experience, with PPPs comprising 20% and 15% of those countries' capital budgets respectively. Portugal reported the highest payments for PPPs, representing nearly 28% of the national budget or 9.4% of GDP; projects could add up to nearly 20% of GDP eventually (OECD 2009).

2.7 Appendix

Table 2.1: PS-TEST

Variable	Treated	Control	%bias	t	p>t
population_2009	35367	25448	12.5	1.35	0.181
population_1999	33663	24598	12.1	1.28	0.202
area	28626	31886	-3.1	-0.47	0.638
population_2009_men	16976	11728	14.2	1.38	0.169
accomodations_2009	19662	14281	12.9	1.25	0.213
main_residences_2009	16976	11728	14.2	1.38	0.169
second_residences_2009	1240.9	1517.9	-7.2	-0.43	0.667
vacant_accomodations_2009	1444.6	1034.6	11.8	1.24	0.217
owned_residences_2009	6965.3	5266.6	10.9	1.24	0.216
income_2009	4.7e+08	3.3e+08	13.0	1.32	0.189
taxpayers_2009	20678	14983	12.2	1.32	0.190
workers_2009	20195	14291	15.8	1.25	0.215
long_term_workers_2009	18327	13000	15.9	1.23	0.222
workers_1999	17857	12670	15.6	1.22	0.223
population_15-64_2009	23938	16610	14.0	1.41	0.159
unemployed_15-64_2009	2419	1658.1	13.3	1.43	0.155
employed_15-64_2009	16637	11732	14.0	1.38	0.169
total_firms_2010	3471.8	2432.9	12.8	1.34	0.181
agriculture_firms_2010	46.94	37.58	15.8	0.93	0.354
industry_firms_2010	155.95	118.12	11.6	1.25	0.214
construction_firms_2010	241.12	194.08	6.6	0.94	0.346
services_firms_2010	2466	1717.9	13.1	1.31	0.192
trade_firms_2010	702.65	536.27	10.7	1.09	0.279
public_firms	561.76	365.2	14.3	1.52	0.131
SMEs	998.84	706.87	13.7	1.34	0.183
No_SMEs	268.11	196.87	14.4	1.19	0.235

Table 2.2: PS-TEST pre 2009

Variable	Treated	Control	% bias	t	p>t
taxpayers_08	26544	23728	3.3	0.24	0.808
net_income_08	5.8e+08	6.4e+08	-2.3	-0.16	0.874
total_tax_08	3.4e+07	5.5e+07	-6.1	-0.42	0.673
taxable_income_08	4.7e+08	5.5e+08	-3.2	-0.23	0.821
notaxable_income_08	1.1e+08	9.2e+07	6.6	0.51	0.611
taxpayers_07	26398	23598	3.3	0.24	0.808
net_income_07	5.7e+08	6.3e+08	-2.4	-0.17	0.867
total_tax_07	3.7e+07	5.9e+07	-6.0	-0.42	0.678
taxable_income_07	4.6e+08	5.5e+08	-3.3	-0.23	0.818
notaxable_income_07	1.0e+08	8.5e+07	7.0	0.54	0.591
taxpayers_06	26198	23445	3.3	0.24	0.810
net_income_06	5.4e+08	6.0e+08	-2.3	-0.16	0.873
total_tax_06	3.5e+07	5.5e+07	-6.0	-0.41	0.680
taxable_income_06	4.4e+08	5.2e+08	-3.2	-0.23	0.821
notaxable_income_06	1.0e+08	8.6e+07	6.7	0.51	0.610
taxpayers_05	25780	23239	3.0	0.22	0.823
net_income_05	4.2e+08	4.7e+08	-2.4	-0.17	0.864
taxpayers_04	25755	23259	3.0	0.22	0.827
net_income_04	4.1e+08	4.6e+08	-2.6	-0.18	0.856
taxpayers_03	25594	23261	2.8	0.20	0.839
net_income_03	4.0e+08	4.5e+08	-2.6	-0.18	0.854
taxpayers_02	25277	23001	2.7	0.20	0.841
net_income_02	3.8e+08	4.3e+08	-2.6	-0.18	0.855
taxpayers_01	24883	22830	2.5	0.18	0.855
net_income_01	3.6e+08	4.2e+08	-3.1	-0.22	0.826
taxpayers_00	24514	22288	2.8	0.20	0.840
net_income_00	3.5e+08	4.1e+08	-3.0	-0.21	0.833
taxpayers_99	24184	22021	2.7	0.20	0.843
net_income_99	3.4e+08	3.9e+08	-3.0	-0.21	0.834
taxpayers_98	23890	21870	2.6	0.19	0.852
net_income_98	2.1e+09	2.4e+09	-2.8	-0.19	0.846

Table 2.3: Panel Dataset description

	Group « PFI/CP » 95 obs	Group « No PFI/CP » 202 obs
PFI/CP investment (€ mil)	32.3	0
PFI/CP choice	1	0
subventions (€ mil)	24.42	21.58
investment (€ mil)	26.2	29.9
current result (€ mil)	4.8	5.5
overall result (€ mil)	4.7	5.9
debt (€ mil)	63.6	45.2
debt per capite	137%	112%

Table 2.4: Definition of variables and expected results

DIMENSION	VARIABLE	DEFINITION	EXPECTED RESULT
DEPENDANT VARIABLES			
	$pfi - choice_{it}$	Equals to 1 if municipality i already invest in PFI/CP at time t	
INDEPENDANT VARIABLES (all variables are defined as difference with the average of the reference group)			
Budget constraint	$debt_{it-1}$	log of debt amount of each municipality at time t-1	+
	$annuity_{it-1}$	log of debt annuity of each municipality at time t-1	+
	$CAF - net_{it-1}$	log of the capability of self financing at t-1	-
	$debt - change_{it-1}$	log of change in debt at t-1	+
Legal change	$rule_t$	Equals to 1 since 2011; 0 otherwise	-
	$rule_t * debt_{it-1}$	Interaction between the variable rule and debt	-
	$rule_t *$ $annuity_{it-1}$	Interaction between the variable rule and annuity	-
	$rule_t * CAF -$ net_{it-1}	Interaction between the variable rule and CAF net	+
	$rule_t * debt -$ $ch._{it-1}$	Interaction between the variable rule and debt change	-
Demand side	$population_i$	Equals to the log of the population of each municipality	
	$income_i$	Equals to the log of oncome of each municipality	
	$firm_i$	Equals to the log of nb. of firm	
Supply side	$Overall -$ $results_{it-1}$	Equals to the log of the budget result of municipality i at t-1	
	$Current - results_{it-1}$	Equals to the log of the current budget result of municipality i at t-1	
	$Subventions_{it-1}$	Equals to the log of the subventions of municipality i at t-1	
	$Investment_{it-1}$	Equals to the log of the investment of municipality i at t-1	-
Others	EQI_i	Equals to the European Quality of Region Government Index	

Table 2.5: Duration estimation: Cox PH Model

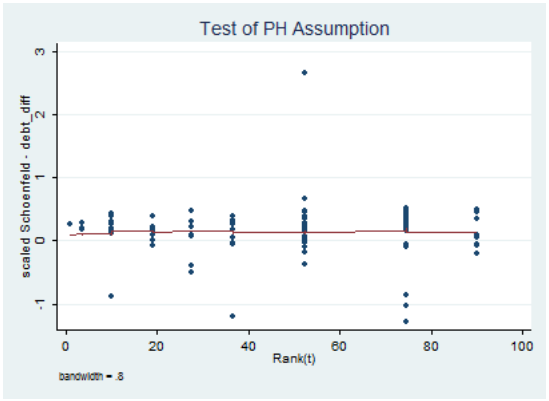
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	_t	_t	_t	_t	_t	_t	_t	_t
overall_budget	0.0246	0.0259	0.00309	0.00714	0.00256	-0.00479	0.0948	0.0727
	(0.06)	(0.07)	(0.01)	(0.02)	(0.01)	(-0.01)	(0.25)	(0.19)
current_budget	0.359	0.342	0.309	0.294	0.283	0.280	0.267	0.249
	(0.80)	(0.76)	(0.67)	(0.64)	(0.65)	(0.65)	(0.64)	(0.60)
subventions	-0.319	-0.306	-0.300	-0.288	-0.273	-0.274	-0.176	-0.160
	(-0.72)	(-0.69)	(-0.66)	(-0.64)	(-0.64)	(-0.64)	(-0.43)	(-0.39)
investment	-0.0671	-0.0659	-0.112	-0.112	-0.259	-0.277	-0.0116	-0.0215
	(-0.26)	(-0.26)	(-0.44)	(-0.43)	(-0.96)	(-1.04)	(-0.05)	(-0.08)
EQI	-0.00629	-0.00522	-0.0100	-0.00899	-0.0338	-0.0347	-0.00635	-0.00382
	(-0.19)	(-0.16)	(-0.31)	(-0.28)	(-0.88)	(-0.90)	(-0.19)	(-0.11)
population	-0.0139	-0.0143	-0.0140	-0.0144	-0.0197	-0.0207	-0.0126	-0.0132
	(-0.70)	(-0.72)	(-0.70)	(-0.72)	(-0.96)	(-1.01)	(-0.62)	(-0.65)
income	0.000315	-0.000224	0.000908	0.000327	-0.000742	0.00158	-0.000239	0.000818
	(0.01)	(-0.01)	(0.02)	(0.01)	(-0.02)	(0.04)	(-0.01)	(0.02)
firm	-0.0463	-0.0470	-0.0820	-0.0806	0.0129	0.0104	0.0531	0.0522
	(-0.77)	(-0.78)	(-1.33)	(-1.31)	(0.25)	(0.20)	(1.04)	(1.02)
debt	0.142***	0.173**						
	(2.61)	(2.47)						
rule_debt		-0.0443						
		(-0.78)						
annuity			0.254***	0.286***				
			(3.14)	(3.03)				
rule_annuity				-0.0525				
				(-0.76)				
debt					0.349**	0.353**		
					(2.34)	(2.38)		
caf_net					0.0444*	0.0229		
					(1.83)	(0.83)		
rule_caf_net						0.0519		
						(1.46)		
debt_change							-0.00860	0.0187
							(-0.61)	(0.89)
rule_debt_ch.								-0.0504*
								(-1.75)
N	2395	2395	2395	2395	2348	2348	2394	2394
post2011		0.128**		0.234***		0.0748**		-0.0316
t		2.277		2.801		2.248		-1.596
PH gl. test (chi2)	5.87	5.02	5.38	4.23	6.68	6.56	7.85	5.20
p value	0.7529	0.8899	0.8644	0.9272	0.7554	0.8335	0.5498	0.8774

t statistics in parentheses

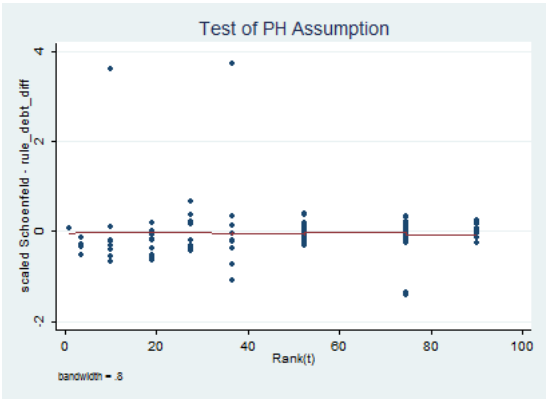
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.6: PH test for budget constraint regressors

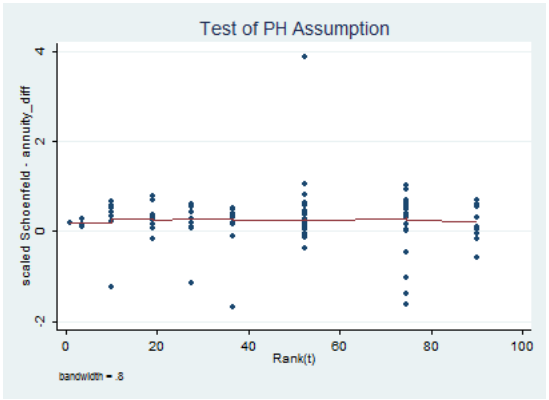
Debt



Rule*Debt



annuity



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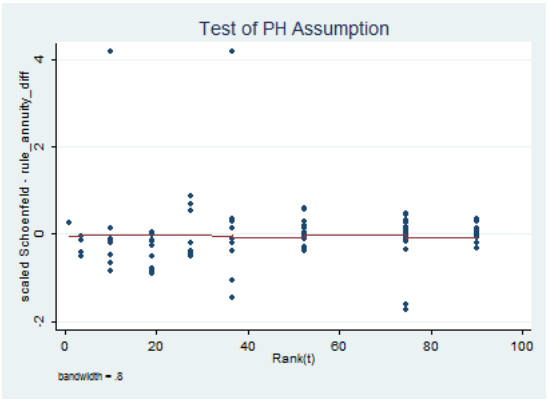
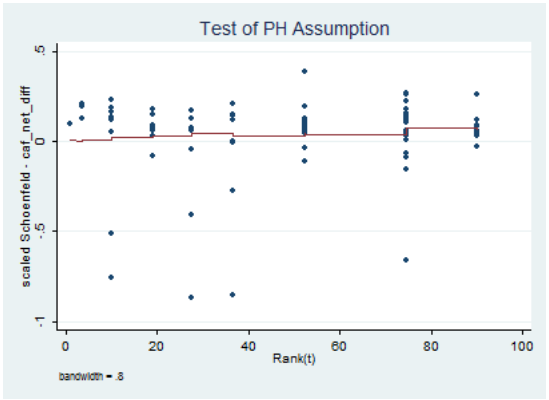
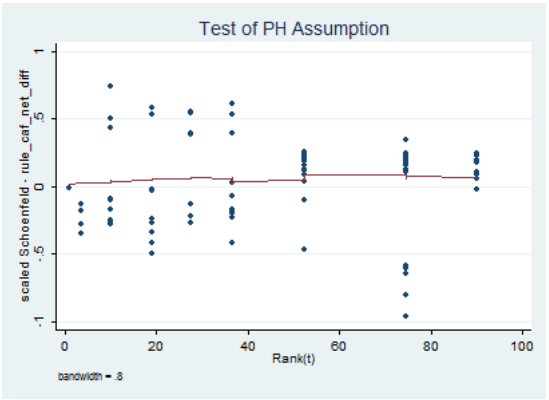


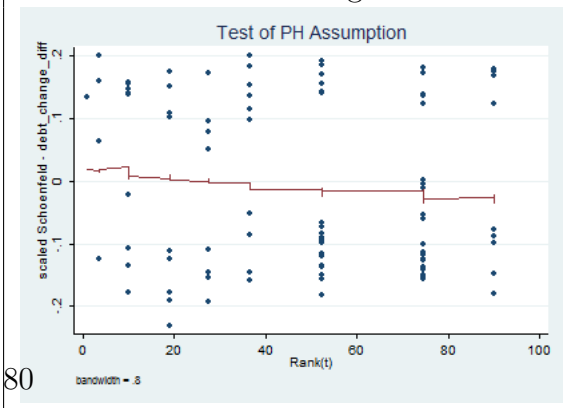
Caf-net



Rule*Caf-net



Debt-change



Rule*Debt-Change

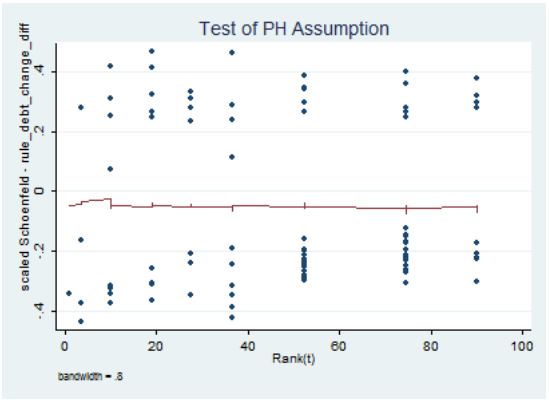


Table 2.7: Parametric Survival Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	_t	_t	_t	_t	_t	_t	_t	_t
population	0.0305	0.0314	0.0192	0.0219	0.00270	-0.00505	0.104	0.0847
	(0.08)	(0.08)	(0.05)	(0.06)	(0.01)	(-0.01)	(0.27)	(0.22)
income	0.384	0.374	0.339	0.328	0.302	0.294	0.284	0.270
	(0.85)	(0.82)	(0.73)	(0.71)	(0.70)	(0.68)	(0.69)	(0.66)
firm	-0.352	-0.345	-0.343	-0.335	-0.298	-0.295	-0.208	-0.196
	(-0.79)	(-0.78)	(-0.76)	(-0.74)	(-0.70)	(-0.70)	(-0.51)	(-0.49)
EQI	-0.0748	-0.0767	-0.118	-0.121	-0.268	-0.285	-0.0145	-0.0204
	(-0.29)	(-0.30)	(-0.46)	(-0.47)	(-0.98)	(-1.05)	(-0.06)	(-0.08)
overall_budget	-0.00490	-0.00399	-0.00810	-0.00710	-0.0291	-0.0314	-0.00831	-0.00500
	(-0.15)	(-0.12)	(-0.25)	(-0.22)	(-0.76)	(-0.82)	(-0.24)	(-0.15)
current_budget	-0.00983	-0.0101	-0.00954	-0.00984	-0.0155	-0.0162	-0.00784	-0.00920
	(-0.49)	(-0.51)	(-0.48)	(-0.49)	(-0.76)	(-0.80)	(-0.39)	(-0.45)
subventions	0.00362	0.00306	0.00603	0.00542	0.00224	0.00537	0.000164	0.00103
	(0.09)	(0.07)	(0.14)	(0.13)	(0.05)	(0.13)	(0.00)	(0.02)
investment	-0.0475	-0.0479	-0.0761	-0.0743	0.0147	0.0101	0.0583	0.0573
	(-0.78)	(-0.78)	(-1.23)	(-1.20)	(0.28)	(0.19)	(1.15)	(1.13)
rule	-0.688*	-0.304	-0.694*	-0.295	-0.713*	-1.012**	-0.705*	-0.744*
	(-1.81)	(-0.45)	(-1.82)	(-0.44)	(-1.88)	(-2.37)	(-1.84)	(-1.92)
debt	0.144***	0.172**						
	(2.63)	(2.43)						
rule_debt		-0.0398						
		(-0.69)						
annuity			0.248***	0.280***				
			(3.06)	(2.94)				
rule_annuity				-0.0511				
				(-0.72)				
debt					0.347**	0.355**		
					(2.31)	(2.37)		
caf_net					0.0408*	0.0175		
					(1.70)	(0.64)		
rule_caf_net						0.0578		
						(1.60)		
debt_change							-0.0117	0.0169
							(-0.83)	(0.80)
rule_debt_ch.								-0.0525*
								(-1.82)
_cons	-7074.4***	-7070.1***	-7098.7***	-7110.5***	-6924.5***	-6986.3***	-7075.9***	-7048.2***
	(-5.23)	(-5.23)	(-5.26)	(-5.27)	(-5.11)	(-5.15)	(-5.22)	(-5.17)
N	2395	2395	2395	2395	2348	2348	2394	2394
post2011		0.132		0.229		0.0754		-0.0356
t		2.327**		2.737***		2.227**		-1.794*

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.8: Random Logit estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	treatment	treatment	treatment	treatment	treatment	treatment	treatment	treatment
EQI	0.0550	0.0557	0.0516	0.0546	0.0849	0.0995	0.109	0.0784
	(0.14)	(0.14)	(0.13)	(0.14)	(0.22)	(0.26)	(0.28)	(0.20)
population	-0.00000192	-0.00000198	-0.00000171	-0.00000177	-0.00000161	-0.00000161	-0.00000236	-0.00000194
	(-0.35)	(-0.36)	(-0.31)	(-0.32)	(-0.29)	(-0.29)	(-0.43)	(-0.35)
income	-0.0648	-0.0694	-0.127	-0.130	-0.150	-0.166	0.0373	0.0312
	(-0.44)	(-0.47)	(-0.85)	(-0.86)	(-0.89)	(-0.98)	(0.27)	(0.22)
firm	0.0000293	0.0000294	0.0000260	0.0000259	0.0000233	0.0000246	0.0000293	0.0000239
	(0.55)	(0.55)	(0.49)	(0.49)	(0.44)	(0.46)	(0.55)	(0.45)
overall_budget	-0.00828	-0.00680	-0.0121	-0.0107	-0.0249	-0.0249	-0.00770	-0.00462
	(-0.25)	(-0.20)	(-0.37)	(-0.33)	(-0.65)	(-0.65)	(-0.22)	(-0.13)
current_budget	-0.0129	-0.0132	-0.0134	-0.0136	-0.0171	-0.0179	-0.0118	-0.0127
	(-0.64)	(-0.65)	(-0.66)	(-0.67)	(-0.82)	(-0.85)	(-0.57)	(-0.61)
subventions	0.00406	0.00341	0.00308	0.00234	-0.00227	-0.000815	0.00529	0.00643
	(0.09)	(0.08)	(0.07)	(0.05)	(-0.05)	(-0.02)	(0.12)	(0.15)
investment	-0.0425	-0.0437	-0.0785	-0.0771	0.0133	0.00980	0.0519	0.0498
	(-0.69)	(-0.71)	(-1.23)	(-1.21)	(0.24)	(0.18)	(0.99)	(0.95)
trend_rule	-0.945**	-0.943**	-0.973**	-0.971**	-0.982**	-0.993**	-0.953**	-0.932**
	(-2.33)	(-2.32)	(-2.39)	(-2.39)	(-2.42)	(-2.44)	(-2.35)	(-2.29)
debt	0.136**	0.173**			0.249*	0.248*		
	(2.43)	(2.43)			(1.81)	(1.80)		
rule_debt		-0.0563						
		(-0.98)						
annuity			0.244***	0.284***				
			(2.95)	(2.98)				
rule_annuity				-0.0667				
				(-0.97)				
caf_net					0.0300	0.00204		
					(1.35)	(0.08)		
rule_caf_net						0.0704**		
						(1.99)		
debt_change							-0.00580	0.0203
							(-0.41)	(0.98)
rule_debt_ch.								-0.0504*
								(-1.74)
_cons	4.501	4.758	5.660	5.885	4.851	5.010	3.047	2.982
	(1.18)	(1.24)	(1.47)	(1.53)	(1.27)	(1.31)	(0.81)	(0.80)
N	2950	2950	2950	2950	2898	2898	2655	2655
post2011		0.117		0.217		0.0724		-0.0302
t		2.038**		2.551**		2.219 **		-1.475

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.9: Chamberlain's Random Logit estimation

	(1)	(2)	(5)	(6)	(7)	(8)	(9)	(10)
	treatment	treatment	treatment	treatment	treatment	treatment	treatment	treatment
EQI	0.141	0.126	0.193	0.194	0.237	0.273	0.267	0.248
	(0.35)	(0.31)	(0.47)	(0.47)	(0.60)	(0.69)	(0.68)	(0.62)
population	-0.00000131	-0.00000136	-0.00000731	-0.00000817	-0.00000116	-0.000000779	-0.00000224	-0.00000193
	(-0.24)	(-0.25)	(-1.02)	(-1.12)	(-0.20)	(-0.13)	(-0.40)	(-0.35)
income	-0.0386	-0.0321	-0.0430	-0.0235	-0.180	-0.191	0.0301	0.0241
	(-0.23)	(-0.19)	(-0.25)	(-0.13)	(-0.95)	(-1.00)	(0.20)	(0.16)
firm	0.0000233	0.0000231	0.0000180	0.0000267	0.0000157	0.0000148	0.0000287	0.0000247
	(0.43)	(0.43)	(0.32)	(0.46)	(0.29)	(0.26)	(0.53)	(0.46)
overall_budget	-0.00194	0.00108	-0.00136	0.00170	-0.0271	-0.0278	-0.00357	0.00186
	(-0.05)	(0.03)	(-0.04)	(0.05)	(-0.67)	(-0.69)	(-0.10)	(0.05)
current_budget	-0.0103	-0.0103	-0.00943	-0.00763	-0.0155	-0.0162	-0.00797	-0.00829
	(-0.50)	(-0.50)	(-0.45)	(-0.37)	(-0.73)	(-0.76)	(-0.38)	(-0.40)
subventions	-0.00805	-0.00752	-0.0128	-0.0114	-0.00902	-0.00871	-0.00744	-0.00595
	(-0.17)	(-0.16)	(-0.27)	(-0.24)	(-0.19)	(-0.18)	(-0.16)	(-0.13)
investment	-0.0306	-0.0267	-0.0517	-0.0527	-0.0175	-0.0187	-0.00537	-0.00373
	(-0.43)	(-0.37)	(-0.71)	(-0.72)	(-0.25)	(-0.26)	(-0.07)	(-0.05)
trend_rule	-0.945**	-0.949**	-0.973**	-0.970**	-0.972**	-0.994**	-0.943**	-0.925**
	(-2.32)	(-2.33)	(-2.39)	(-2.39)	(-2.39)	(-2.43)	(-2.32)	(-2.27)
debt	0.117	0.202*			-0.561	-0.525		
	(1.19)	(1.75)			(-1.62)	(-1.52)		
rule_debt		-0.183						
		(-1.35)						
annuity			0.242**	0.257**				
			(2.33)	(2.30)				
rule_annuity				-0.0273				
				(-0.38)				
caf_net					0.0395	-0.00423		
					(1.63)	(-0.15)		
rule_caf_net						0.105**		
						(2.39)		
debt_change							-0.0119	0.00693
							(-0.79)	(0.31)
rule_debt_ch.								-0.0380
								(-1.23)
_cons	3.988	4.130	4.201	4.005	4.635	4.907	2.875	2.865
	(0.99)	(1.03)	(1.03)	(0.97)	(1.17)	(1.23)	(0.74)	(0.74)
N	2950	2950	2950	2950	2898	2898	2655	2655
post2011		0.0196		0.230**		0.101**		-0.0310
t		0.164		2.138		2.697		-1.434

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3 Public and Private Finance of PPPs

Author: Marco Buso

Abstract

This theoretical paper studies the effect of public and private budget constraints on the government's choice between Public Private Partnerships (PPPs) and Traditional Procurement (TP) mechanisms. Differently from the previous literature, I introduce private limited liability and public budget constraints in a context characterized by asymmetric information. In this framework, private agents are protected in case of bad outcomes from the probability of failure. Furthermore, public transfers are socially costly for the government.

Under PPPs, the private consortium, thanks to its long term commitment in the project, owns an implicit incentive to invest during the building stage. As a consequence, the agent can accept higher levels of risks and the the government can save money in the form of incentive rents.

This paper provides a theoretical explanation for the empirical evidence which shows how budget constrained governments are more apt to choose PPPs (Hammami et al., 2006; Albalate et al., 2012; Russo and Zampino, 2010; Krumm and Mause, 2012; Buso et al., 2013). The result is not derived from the presence of private financing, but it comes from the introduction of asymmetric information in conditions of financial stress.

3.1 Introduction

The involvement of private companies for the realization and provision of public goods and services is not a recent practice; it has been adopted since the introduction

of concession contracts in the legal system. Nevertheless, programs launched in the early 1990s in the UK and other countries to enhance public-private partnerships (PPPs) differ from traditional forms of public-private collaboration by the greater emphasis placed on "value for money"[1].

Since the 1990s, the importance of PPPs in public sector infrastructure substantially increased until the onset of the financial crisis, which downsized the phenomenon. The main factors driving this growth have been: 1) the possibility of new sources of financing, 2) the optimal allocation of risks among agents and the incentives provided by bundling structures[2]. It is not clear which of these elements can best explain the advantages of PPPs, and the advantages claimed by practitioners are not always in accordance with theory. For instance, governments and private contractors highlight both the efficiency gains of PPPs and their ability to release public funds. The theoretical literature emphasizes, however, the potential efficiency advantages or disadvantages of PPPs, while it doesn't support their ability to relieve strained budgets (Engel et a. 2013).

In contrast to the theoretical literature, empirical evidence shows that tax burden and debt stress levels are important elements in explaining the preferences of countries or municipalities towards PPPs (Hammami et al., 2006; Albalate et al., 2012; Russo and Zampino, 2010; Krumm and Mause 2012). None of the previous works clarify, however, the nature of this effect, i.e. whether this impact is driven by political motivations (debt hiding). Buso et al. (2014) delve further in their analysis. Applying a natural experiment to the French context, they show how political (debt hiding) reasons are not sufficient to explain why municipalities burdened by strict budget constraints are more apt to choose PPPs.

This paper contributes to the theoretical financial literature regarding PPPs by analyzing whether the efficiency advantages of PPPs increase with the financial constraints of collectivities. The analysis shows a positive impact of PPPs on the government budget. This effect is not derived from the introduction of private financing, but is based on an efficiency gains. This can explain the empirical results

[1]The "value for money" analysis evaluates the economic sustainability of the project and it defines the optimal allocation of risks between the public and the private partners.

[2]An important characteristic of PPPs is the assignment of different phases of the project to a single consortium made of more agents. This bundling agreement includes several activities depending on the choice of contract, some examples are: the BOT (Build, Operate and Transfer), the BOOT (Build Operate Own and Transfer) or the FDBO (Finance, Design, Build, Operate, Transfer)

found by Buso et al. (2014).

The paper is structured in four main sections: Section 1 discusses the related literature; Section 2 presents the model; Section 3 compares PPPs and TP using a welfare analysis; finally, section 4 concludes.

3.2 Related literature review

Most of the theoretical papers aim to testing the positive and negative impact of PPPs on TP mechanisms in the form of social welfare. PPPs can encourage cost-reducing innovations (Hart, 2003; Bennet and lossa, 2006) and, when the externality between the building and the operational phase is positive, quality-enhancing investments (Martimort and Pouyet, 2008; lossa and Martimort, 2008). Nevertheless, because of the early commitment required, they don't allow for needed flexibility in the face of uncertain future determinants (lossa and Martimort, 2008; 2011; Martimort and Straub, 2012). Space for welfare-improving PPPs is further restricted when there are: 1) limitations on the governments' ability to commit for long term projects (Guash et al., 2005; Valero, 2013); 2) soft budgets and re-negotiations (de Bettignies and Ross, 2008; Engel et al., 2009); and 3) the presence of a government's preference for a favored group (Maskin and Tirole, 2007).

On the other hand, when determining at the optimal degree of private involvement in public projects, a major role is played by distortionary costs of financing (Atkinson and Stern, 1974) and uncertainty (Arrow and Lind, 1970). Deregulation of non-competitive sectors implies a trade-off between benefits for taxpayers and costs for consumers, where privatization is more likely to be the solution the higher the shadow cost of public funds (Auriol and Picard, 2007) and the more ex post renegotiations are allowed (Auriol and Picard, 2009). This trade off also persists when 'build operate transfer' (BOT) concession contracts and public regimes are compared (Auriol and Picard, 2013). In such a case, governments' incentive to opt for BOT contracts increase the higher the degree of asymmetric information, the larger the shadow cost of public funds, and the larger the business risk.

Nevertheless, distortionary taxation is not always an argument in favor of private involvement. Engel et al. (2013) develop a model where a large government able to diversify risk contracts with a risk averse firm for a small project. In such a context,

the government savings during the early investment of the PPP are perfectly offset by future revenue flows. Hence, the shadow cost of public funds can affect the analysis only when it changes over time (liquidity constraints).

In this paper I develop a stylized model where the government must choose between contracting out the realization of a multi-stage project to a single consortium (PPPs) or distributing the several investment stages to different agents (Traditional Procurement - TP). The model is developed in a context of asymmetric information (moral hazard). Furthermore, public institutions face budget limitations (public budget constraint)[3], while, different to the previous literature, private firms are restrained in the financial resources they can collect (private limited liability constraints)[4]. The analysis follows the approach of Engel et al. (2013) but introducing further financial aspects that characterize the current investment environment.

3.3 The model

In the model, the government acts as a principal and must implement a public investment composed of two stages: an infrastructure component and the management of the completed infrastructure.

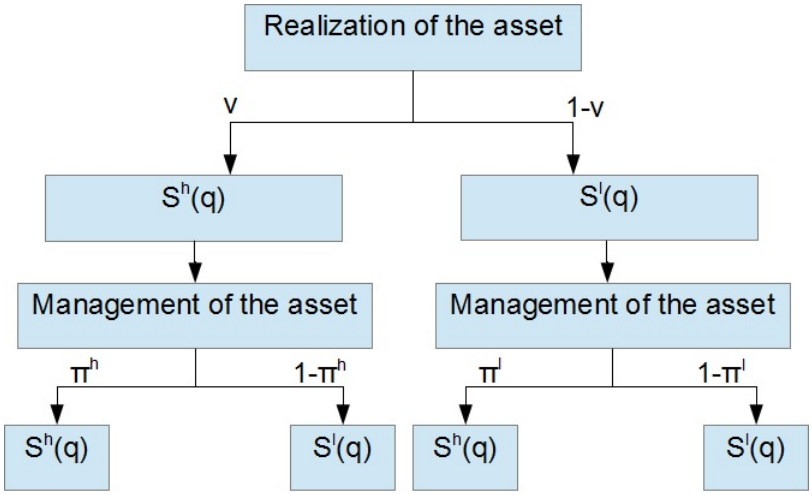
During the first stage, the agent must build an asset of size q that generates a surplus for the public. The surplus function $S(q)$ is increasing and concave with respect to the investment size $S_q > 0$, $S_{qq} \leq 0$. Furthermore, depending on the builder's action, it can be equal to $S^l(q)$ or $S^h(q) > S^l(q)$. The builder can exercise a high level of effort: $e_1 = 1$, sustaining a marginal cost equal to $c(1) = c_1$ or a low level: $e_1 = 0$, having a marginal cost equal to $c(0) = c_0 < c_1$. In the first case, the probability to achieve a high level of surplus, $S^h(q)$, is v_1, otherwise it's equal to $v_0 < v_1$.

During the second phase there is still a problem of hidden action. Namely, the operator can exercise a high level of effort: $e_2 = 1$, suffering a non monetary cost equal to $\psi(1) = \psi$ or a low level: $e_2 = 0$, having a marginal cost equal to $\psi(0) = 0$.

[3]They haven't the power to increase the current spending with the promise to raise future taxes because of excessive levels of public debts.

[4]Martimort & Straub (2012) develop an analysis with private limited liability constraints; however, they didn't focus their study on the financial features of PPPs.

The government cannot directly verify the effort, but he can observe the impact of the operational activity on the final levels of social surplus[5], which depend on the effort expended in the first stage[6]. Indeed, when the construction results in a social surplus equal to $S^h(q)$, the operator has a probability to maintain the same level of surplus during the management period equal either to π_1^h if he implements a high level of effort or $\pi_0^h < \pi_1^h$ if the operator exerts a low level. Nevertheless, when the social welfare function at the end of the building activity is equal to $S^l(q)$, the operator can obtain a consumer surplus of $S^h(q)$ with either probability π_1^l when $e_2 = 1$ or $\pi_0^l < \pi_1^l$ otherwise. As a matter of fact, effort during the investment stage shifts the probability distribution towards higher expected realizations of the operational activity: $\pi^h > \pi^l$. Without loss of generality, the model furtherly assumes that $\Delta\pi^h = \Delta\pi^l$. The design of the model is summarized through the following diagram:



The sequential phases of the project could be assigned to two separate agents or to a single consortium. In the first case there are two contracts and an unbundled structure (TP), in the second case there is a consortium made of two agents and a single contract that regulates both activities (PPPs). These organizational choices are compared in the following paragraphs.

[5]This outcome can be evaluated by different measures, such as the availability of public asset to the final consumers.

[6]If, for instance, the infrastructure construction experiences a significant delivery delay, the operational phase experience a shorter activity period due to a decreased need for the public services.

3.3.1 Unbundling - TP

In the "unbundling", the government assigns the two stages of the project to different agents: the builder and the operator. These players act autonomously and the government offers two different contracts.

1. In the first phase, the principal offers a transfer contingent on the achievement of a high level of surplus: $S^h(q)$. In case of success, the subsidy is equal to t_1^h, otherwise the punishment is equal to t_1^l ($t_1^h > t_1^l$). These values are set in order to induce the participation of the builder and to create an incentive for a high level of effort. Furthermore, the government must take into account the limited liability constraint in case of unsuccessful outcome; it reflects the risk aversion of the agent and it represents a limit to the government's ability to apply a punishment.
2. In the second phase, the government offers a transfer contingent on the final outcome. Specifically, if the final users' surplus results equal to $S^h(q)$ the transfer correspond to t_2^h, otherwise the penalty is equal to t_2^l ($t_2^h > t_2^l$). The amount of the subsidy is set with the purpose of making the operator participate in the contract and provide high levels of effort. Also in this phase the operator is protected in the event of bad outcomes by a limited liability constraint.

After the contractual agreements, the two agents are left with a payoff that is respectively equal to:

- $U_1 = E[t_1] - c(e)q$ for the builder;
- $U_2 = E[t_2] - \psi(e)$ for the operator.

Taking into account the setting described above, the government maximizes its constrained net payoff to decide on the size of the investment and the adequate amount of transfers. The welfare function is the difference between the expected users' surplus and the expected transfers. The utilities of the agents must be higher than the

reservation values that are equal to 0[7]. Moreover, the agents are protected by limited liability constraints in the event of an unsuccessful outcome and their utilities are set to provide an incentive for high levels of effort. Finally, the government must own an adequate amount of resources (K) to satisfy the contractual requirements. The maximization problem is solved through a backward induction strategy.

Proof. See appendix 1

The final results are summarized by the following table.

Results	
q	$v_1[\pi_1^h S_q^h(q) + (1-\pi_1^h)S_q^l(q)] + (1-v_1)[\pi_1^l S_q^h(q) + (1-\pi_1^l)S_q^l(q)] = (v_1+\beta)\frac{\Delta c}{\Delta v}$
t_1	$t_1^l = 0;\ t_1^h = q\frac{\Delta c}{\Delta v};$
t_2	$t_2^l = 0;\ t_2^h = \frac{\psi}{\Delta \pi}$

The optimal investment size derives from the equality between the expected marginal benefit (left hand size) and the expected marginal cost (right hand size). The expected marginal surplus is computed considering the probability distribution over the two periods when agents implement high levels of effort. The expected marginal costs take into account the Lagrangian multiplier of the budget constraint (β) that captures the distortion imposed to taxpayers for collecting funds needed for the investment.

Limited liability constraints result always more stringent compared to participation constraints. That's the reason why the level of transfers in case of bad outcomes are, in equilibrium, equal to zero, both in the building and operation stages. Transfers in cases of good final outcomes are accordingly adjusted taking furtherly into account incentive compatibility constraints.

[7]The Participation constraints are never binding because the limited liability constraints are always more stringent.

3.3.2 Bundling - PPPs

In the "bundling" framework the government hires a single consortium of two firms for both the construction and the operation stages of the project. The setting and the initial assumptions are very similar to the unbundling scenario, but a single contract is submitted. The deal is composed by two transfers, one for each stage of the project. The resulting utility of the consortium is equal to:

- $U_1 = E[t_1] + E[t_2] - c(e)q - \psi(e)$

During both investment phases there is a problem of hidden action. The government maximizes its ex ante gross surplus net of the expected payments granted to the consortium. The principal has to induce the agent to both participate in the project and provide a high level of effort. Moreover, the consortium cannot be excessively punished in case of an unsuccessful outcome and the government must own adequate resources to cover the maximum total expenses. The maximization problem aims to define the optimal levels of investment and transfers.

Proof. See appendix 2

The final results are reported in the following table:

Results	
q	$v_1[\pi_1^h S_q^h(q) + (1-\pi_1^h)S_q^l(q)] + (1-v_1)[\pi_1^l S_q^h(q) + (1-\pi_1^l)S_q^l(q)] = (v_1+\beta)\frac{\Delta c}{\Delta v}$
t	$t_1^h - t_1^l = \frac{\Delta c}{\Delta v}q - (\pi_1^h - \pi_1^l)(\frac{\psi}{\Delta\pi})$; $t_2^h - t_2^l = \frac{\psi}{\Delta\pi}$; $t_1^l + t_2^l = 0$

Similarly to the unbundling scenario, the optimal investment size is set equalizing the marginal benefit with the marginal cost deriving from an additional unit of investment. Concerning the level of transfers, it's interesting to observe that, differently from the previous scenario, the limited liability constraint is considered over the two periods and the builder's incentive compatibility constraint takes into account the impact that the first stage has in probabilities into the second stage.

3.4 Welfare analysis

This section performs a welfare analysis to analyze the pros and cons of choosing a PPP. As a working hypothesis, I propose that the gross surplus of a benevolent government is respectively equal to: $S^h(q) = 2ln(q)$ in case of a successful outcome, and $S^l(q) = ln(q)$ otherwise[8]. Starting from these assumptions, it is possible to compare the total production of the unbundled and the bundled structures and the subsequent value functions.

Proof. See appendix 3

The final results are summarized by the following table:

	Quantity
Unbundling - TP	$q^U = \frac{K - \frac{\psi}{\Delta\pi}}{\frac{\Delta c}{\Delta v}}$
Bundling - PPPs	$q^B = \frac{K - \frac{\psi}{\Delta\pi}[1-(\pi_1^h - \pi_1^l)]}{\frac{\Delta c}{\Delta v}}$

	Surplus
Unbundling - TP	$V^U = lnq^U[v_1(1+\pi_1^h) + (1-v_1)(1+\pi_1^l)] - v_1K + \frac{\psi}{\Delta\pi}(v_1 - v_1\pi_1^h - (1-v_1)\pi_1^l)$
Bundling - PPPs	$V^B = lnq^B[v_1(1+\pi_1^h) + (1-v_1)(1+\pi_1^l)] - v_1K + \frac{\psi}{\Delta\pi}(v_1 - v_1\pi_1^h - (1-v_1)\pi_1^l)$

Outcomes in both settings depend from K and are strictly comparable. In fact, the difference between PPPs and TP is always positive and it is equal to:

$$[v_1(1+\pi_1^h) + (1-v_1)(1+\pi_1^l)][lnq^B - lnq^U]$$

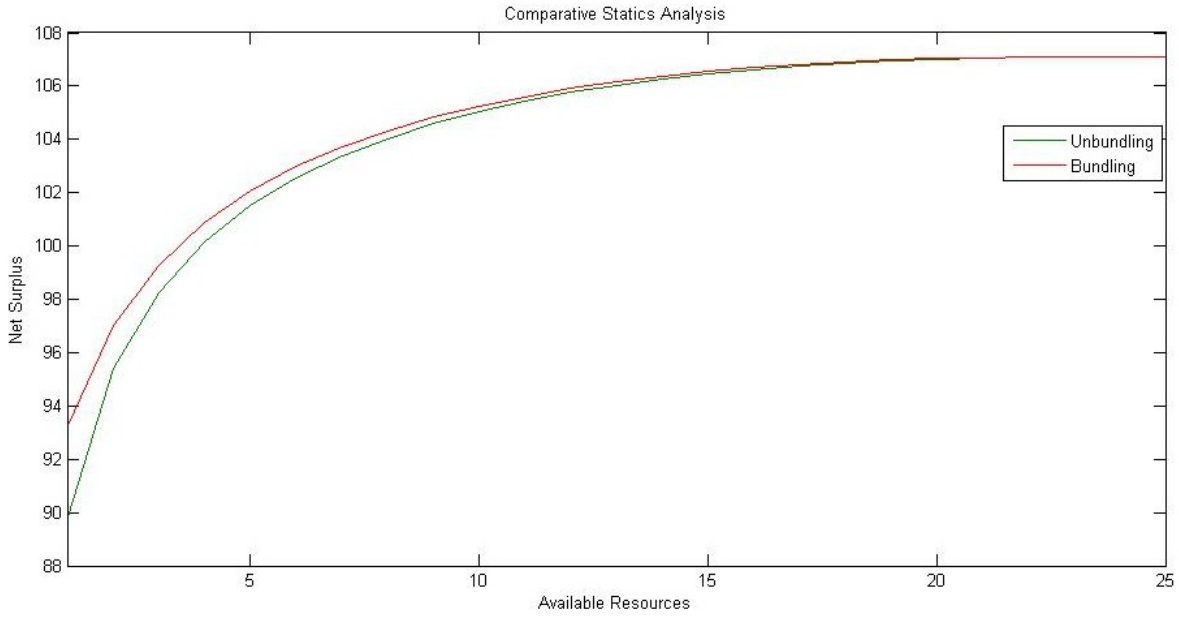
Given the initial assumption: $\pi_1^h > \pi_1^l$, PPPs are always preferred and this advantage increases as available government resources (K) decrease[9]. The analysis allows

[8] These specific functions satisfy the initial assumptions of the model.

[9] In the appendix it can be observed that the difference comes form the Lagrangian multiplier of the budget constraint.

us to understand the final results in light of the moral hazard issue and the financial constraints. A bundled structure with a long term contract is more likely to accept the transfer of endogenous risks. As a consequence, a budget-constrained government offering contracts contingent on adequate performance is able to implement a project that is less costly in terms of final rents. Put differently, the private agents ask the government for an insurance cost due to a higher degree of risk aversion[10]. In the case of PPPs, the investment perspective of the private agent is longer, therefore the consortium has an implicit incentive that lowers the required insurance premium. It is important to highlight how this benefit does not result from the involvement of private finance, but rather from the optimal transfer of risks in a context of asymmetric information. This enriches the analysis of Engel et al. (2013), but doesn't directly contrast the "irrelevance theorem". The analytical result can be graphically described by an example:

Table 3.1: Simulation analysis



The simulation analysis has been performed based on the level of available public resources. When there are low values of K, TP is preferred to PPPs. As K increases, the government budget constraint is less relevant for the analysis and the two organizational structures are more similar in terms of ex ante net surplus.

[10]The higher degree of risk aversion comes from the limited liability constraints.

3.5 Conclusion

In this paper, two organizational choices are compared: PPPs (bundling) and TP (unbundling). Most studies on PPPs focus on the same research question, while the financial aspect of the problem is often neglected. In the model presented, the approach is similar to that in the related literature in that there is a project made of two related stages. However, in this study both government and private partners are constrained in their capacity to collect the needed funds.

The motivation of the paper is similar to that of Engel et al. (2013), but the framework better reflects the current situation of public and private financial markets. Because of this environment, private players can not be excessively punished due to the risk of failure and the government has limited resources to provide investment incentives. PPPs imply a long term relationship between government and private agents. Thanks to this commitment, the consortium is more willing to accept the transfer of risks, therefore the government can enhance the building investment maximizing the level of rent extraction.

The model is still very preliminary and incomplete, but the topic is extremely relevant given the current situation, where public resources are scarce and private markets are risky. Several extensions are possible to include different aspects that are not captured by this theoretical framework.

3.6 Appendix

1 - Unbundling - Maximization proof 1

First-step - Maximization problem of the second stage[11]

$$\underset{t_2^h, t_2^l}{max} \pi_1^i S^h(q) + (1-\pi_1^i) S^l(q) - \pi_1^i t_2^h - (1-\pi_1^i) t_2^l$$

s.t.

1) $\pi_1^i t_2^h + (1-\pi_1^i) t_2^l - \psi \geq 0 \qquad (\mu)$

2) $\pi_1^i t_2^h + (1-\pi_1^i) t_2^l - \psi \geq \pi_0^i t_2^h + (1-\pi_0^i) t_2^l \qquad (\lambda)$

3) $t_2^l \geq 0 \qquad (\gamma)$

4) $t_1^h + t_2^h \leq K \qquad (\beta)$

Results[12]:

$t_2^l = 0$

$t_2^h = \frac{\psi}{\Delta\pi}$

Second-step - Maximization problem of the first stage[13]

$$\underset{q, t_1^h, t_1^l}{max} v_1 \{\pi_1^h S^h(q) + (1-\pi_1^h) S^l(q) - t_1^h - \pi_1^h \tfrac{\psi}{\Delta\pi}\}$$
$$+(1-v_1)\{\pi_1^l S^h(q) + (1-\pi_1^l) S^l(q) - t_1^l - \pi_1^l \tfrac{\psi}{\Delta\pi}\}$$

s.t.

[11] $i = h$ or l depending of the first phase outcome.

[12] Given that the limited libility constraint is always binding and because of the assumption $\Delta\pi^h = \Delta\pi^l$, the maximization problem of the operator leads to the same results whatever is the outcome of the building activity.

[13] It is assumed that the limited liability constraint is always more binding than the participation constraint, in this case it is equivalent to assume that $c_0 v_1 < c_1 v_0$; i.e the cost in case of low level of effort must not be too high.

1) $v_1 t_1^h + (1 - v_1) t_1^l - c_1 q \geq 0 \qquad (\alpha)$

2) $v_1 t_1^h + (1 - v_1) t_1^l - c_1 q \geq v_0 t_1 + (1 - v_0) t_1^l - c_0 q \qquad (\eta)$

3) $t_1^l \geq 0 \qquad (\delta)$

4) $t_1^h + t_2^h \leq K \qquad (\beta)$

Lagrangian function[14]

$$
\begin{aligned}
L = {} & v_1 \{\pi_1^h S^h(q) + (1 - \pi_1^h) S^l(q) - t_1^h - \pi_1^h \tfrac{\psi}{\Delta\pi}\} \\
& + (1 - v_1)\{\pi_1^l S^h(q) + (1 - \pi_1^l) S^l(q) - t_1^l - \pi_1^l \tfrac{\psi}{\Delta\pi}\} \\
& + \eta \left(v_1 t_1^h + (1 - v_1) t_1^l - c_1 q - v_0 t_1^h - (1 - v_0) t_1^l + c_0 q\right) \\
& + \gamma(t_1^l) \\
& + \beta(K - t_1^h - t_2^h)
\end{aligned}
$$

First order conditions

$$
\begin{aligned}
\tfrac{dL}{dq} :& v_1[\pi_1^h S_q^h(q) + (1 - \pi_1^h) S_q^l(q)] + (1 - v_1)[\pi_1^l S_q^h(q) + (1 - \pi_1^l) S_q^l(q)] = \eta \Delta c \\
\tfrac{dL}{dt_1^h} :& -v_1 + \eta \Delta v - \beta = 0 \\
\tfrac{dL}{dt_1^l} :& -(1 - v_1) - \eta \Delta v + \gamma = 0
\end{aligned}
$$

Results:

$$
\begin{aligned}
& v_1[\pi_1^h S_q^h(q) + (1 - \pi_1^h) S_q^l(q)] + (1 - v_1)[\pi_1^l S_q^h(q) + (1 - \pi_1^l) S_q^l(q)] = (v_1 + \beta) \tfrac{\Delta c}{\Delta v} \\
& t_1^l = 0 \\
& t_1^h = q \tfrac{\Delta c}{\Delta v}
\end{aligned}
$$

[14] The participation constrain is never binding

2 - Bundling - Maximization proof 2

Maximization problem of the government's objective function over the two stages[15]

$$\max_{q,t_1^h,t_1^l,t_2^h,t_2^l} v_1\{\pi_1^h S^h(q) + (1-\pi_1^h)S^l(q) - t_1^h - \pi_1^h t_2^h - (1-\pi_1^h)t_2^l\}$$
$$+(1-v_1)\{\pi_1^l S^h(q) + (1-\pi_1^l)S^l(q) - t_1^l - \pi_1^l t_2^h - (1-\pi_1^l)t_2^l\}$$

s.t.

1) $v_1[t_1^h + \pi_1^h t_2^h + (1-\pi_1^h)t_2^l - \psi] + (1-v_1)[t_1^l + \pi_1^l t_2^h + (1-\pi_1^l)t_2^l - \psi] - c_1 q \geq 0 \quad (\mu)$

2) $v_1[t_1^h + \pi_1^h t_2^h + (1-\pi_1^h)t_2^l - \psi] + (1-v_1)[t_1^l + \pi_1^l t_2^h + (1-\pi_1^l)t_2^l - \psi] - c_1 q \geq$
$v_0[t_1^h + \pi_1^h t_2^h + (1-\pi_1^h)t_2^l - \psi] + (1-v_0)[t_1^l + \pi_1^l t_2^h + (1-\pi_1^l)t_2^l - \psi] - c_0 q \quad (\eta)$

3) $v_1[t_1^h + \pi_1^h t_2^h + (1-\pi_1^h)t_2^l - \psi] + (1-v_1)[t_1^l + \pi_1^l t_2^h + (1-\pi_1^l)t_2^l - \psi] - c_1 q \geq$
$v_1[t_1^h + \pi_0^h t_2^h + (1-\pi_0^h)t_2^l] + (1-v_1)[t_1^l + \pi_0^l t_2^h + (1-\pi_0^l)t_2^l] - c_1 q \quad (\lambda)$

4) $t_1^l + t_2^l \geq 0 \quad (\gamma)$

6) $t_1^h + t_2^h \leq K \quad (\beta)$

Lagrangian function[16]

$$L = v_1\{\pi_1^h S^h(q) + (1-\pi_1^h)S^l(q) - t_1^h - \pi_1^h t_2^h - (1-\pi_1^h)t_2^l\}$$
$$+(1-v_1)\{\pi_1^l S^h(q) + (1-\pi_1^l)S^l(q) - t_1^l - \pi_1^l t_2^h - (1-\pi_1^l)t_2^l\}$$
$$+\eta\left(\Delta v[t_1^h - t_1^l + (\pi_1^h - \pi_1^l)(t_2^h - t_2^l)] - c_1 q + c_0 q\right)$$
$$+\lambda\left(\Delta\pi(t_2^h - t_2^l) - \psi\right)$$
$$+\gamma(t_1^l + t_2^l)$$
$$+\beta(K - t_1^h - t_2^h)$$

[15] Even within this framework, it is assumed for simplicity that the limited liability constraint is always more binding than the participation constraint. It is important to highlight that in the bundling case the limited liability constraint is less easily binding with respect to the undundling case. Therefore, with this assumption, we are underestimating the potential benefit of bundling.

[16] The participation constrain is never binding

First order conditions

$$\frac{dL}{dq}: v_1[\pi_1^h S_q^h(q) + (1-\pi_1^h)S_q^l(q)] + (1-v_1)[\pi_1^l S_q^h(q) + (1-\pi_1^l)S_q^l(q)] = \eta\Delta c$$

$$\frac{dL}{dt_1^h}: -v_1 + \eta\Delta v - \beta = 0$$

$$\frac{dL}{dt_1^l}: -(1-v_1) - \eta\Delta v + \gamma = 0$$

$$\frac{dL}{dt_2^h}: -v_1\pi_1^h - (1-v_1)\pi_1^l + \lambda\Delta\pi + \eta\Delta v(\pi_1^h - \pi_1^l) - \beta = 0$$

$$\frac{dL}{dt_2^l}: -v_1(1-\pi_1^h) - (1-v_1)(1-\pi_1^l) - \lambda\Delta\pi - \eta\Delta v(\pi_1^h - \pi_1^l) + \gamma = 0$$

Results:

$$v_1[\pi_1^h S_q^h(q) + (1-\pi_1^h)S_q^l(q)] + (1-v_1)[\pi_1^l S_q^h(q) + (1-\pi_1^l)S_q^l(q)] = (v_1+\beta)\frac{\Delta c}{\Delta v}$$

$$t_1^h - t_1^l = \frac{\Delta c}{\Delta v}q - (\pi_1^h - \pi_1^l)(\frac{\psi}{\Delta\pi})$$

$$t_2^h - t_2^l = \frac{\psi}{\Delta\pi}$$

$$t_1^l + t_2^l = 0$$

3 - Welfare analysis

Given the assumptions: $S^h(q) = 2ln(q)$; $S^l(q) = ln(q)$; the optimal investment size and the Lagrangian multiplier of the budget constraint become:

	Investment size	
Unbundling	$q^U = \frac{v_1(1+\pi_1^h)+(1-v_1)(1+\pi_1^l)}{(v_1+\beta)\frac{\Delta c}{\Delta v}}$	$\beta = \frac{v_1(1+\pi_1^h)+(1-v_1)(1+\pi_1^l)}{K-\frac{\psi}{\Delta\pi}} - v_1$
Bundling	$q^B = \frac{v_1(1+\pi_1^h)+(1-v_1)(1+\pi_1^l)}{(v_1+\beta)\frac{\Delta c}{\Delta v}}$	$\beta = \frac{v_1(1+\pi_1^h)+(1-v_1)(1+\pi_1^l)}{K-\frac{\psi}{\Delta\pi}(1-(\pi_1^h-\pi_1^l))} - v_1$

Substituting in the government objective function, we can compute the value functions under bundling and unbundling:

	Net Surplus
Unbundling	$v_1[\pi_1^h 2ln\left(q^U\right) + (1-\pi_1^h)ln\left(q^U\right)] + (1-v_1)[\pi_1^l 2ln\left(q^U\right) + (1-\pi_1^l)ln\left(q^U\right)]$ $-v_1\pi_1^h\frac{\psi}{\Delta\pi} - (1-v_1)\pi_1^l\frac{\psi}{\Delta\pi} - v_1 q^U\frac{\Delta c}{\Delta v}$
Bundling	$v_1[\pi_1^h 2ln\left(q^U\right) + (1-\pi_1^h)ln\left(q^U\right)] + (1-v_1)[\pi_1^l 2ln\left(q^U\right) + (1-\pi_1^l)ln\left(q^U\right)]$ $-v_1\pi_1^h\frac{\psi}{\Delta\pi} - (1-v_1)\pi_1^l\frac{\psi}{\Delta\pi} - v_1[q^U\frac{\Delta c}{\Delta v} - (\pi_1^h-\pi_1^l)(\frac{\psi}{\Delta\pi})]$

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