Public-private partnerships and the allocation of demand risk
An Incomplete Contract Theory Approach

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Abstract

In this paper, we explore the consequences of the allocation of demand risk in public-private contractual agreements, for infrastructure-based public services. Using an incomplete contract framework, our results show that when the operator bears the demand risk, he gets higher incentives to increase the quality of the service, but this may lead to exclude some citizens from accessing the service. When the demand risk is borne by the public authority, more citizens can access the service but the operator gets lower incentives to innovate and to care for quality. There is then a trade-off between economic performance of a service and equity concern, as regards to access the public service. Social rules that prevail in a society may influence the choice between these two types of contracts.

JEL Codes: L14, L22, L24, L33.
Keywords: Public-private partnership, Incomplete contracts, Efficiency, Equity.

1 Introduction

Public-private partnerships are contracts between a public authority and a private company to build a public facility and/or manage a public service. They have skyrocketed over the past decades, and include very different types of contractual agreements (Delmon [2010]). One of the difference between these various agreements is the allocation of the demand risk that can be borne either by the private party or by the public authority. In this paper, we wonder what are the consequences of this allocation as regards to economic efficiency and equity considerations, and we show how the institutional context may explain part of this allocation choice.

Let us first explain how the demand risk may be allocated differently in public-private agreements. In concession contracts, the private operator is paid through the fees collected on users, *i.e.* the operator bears the demand risk. This should give hime some incentives

to take users' satisfaction into account since it will impact the number of citizens using the service, and then his revenue.
Alternatively, most PFI contracts in the United Kingdom and *contrats de partenariat* in France are availability risk contracts, so that the demand risk is not transferred to the private operator (European Commission [2004]). He is remunerated by a fixed payment by the public authority, provided that some basic verifiable criteria that are decided *ex ante* are fulfiled. This should intuitively provide less incentives to consider users' satisfaction. However a striking fact is that there is an increasing number of examples going the opposite way from these intuitions. In 2010 for instance, *ERDF*, an operator of electricity distribution that has concession contracts with French municipalities, and that has several local competitors[1] was blamed by the French energy regulation authority for important quality decreases due to power cuts (CRE [2010]). Another example is given by a survey made in 2005 based on 900 users of the A77 concession highway that shows that one third of users have an unfavorable or very unfavorable opinion about the quality of service on this highway.[2] Moreover, although operators do not bear the demand risk in availability contracts, this does not seem to inhibit their incentives to consider quality, as underlined by the National Audit Office [2003] who highlights high quality performances in the management of prisons delivered under PFI contracts.
In this paper, we try to adress this issue by wondering whether not to entrust the private operator with the demand risk has a negative impact on the incentives to take care of the quality of service. Symetrically, we wonder whether entrusting the operator with the demand risk necessarily enables to reach a better quality of service and thus a higher consideration for users' satisfaction. Put differently, there is a need to understand whether public authorities should transfer the demand risk to the private operator.
To reach this goal, we use an incomplete contract framework. The assumption of contractual incompleteness is often used to study contracts signed between public and private partners (Hart, Shleifer, and Vishny [1997], Hart [2003], Bennett and Iossa [2006], Hoppe and Schmitz [2010]), mainly because the quality of service often cannot be fully specified by public authorities, nor can they write verifiable objectives for all possible contingencies occuring in the long run. Following Hart [2003], we propose a stylized setting in which there are two stages to a project: the building of an infrastructure and the management of the public service linked to the infrastructure.The public authority delegates these two functions to a private firm, through a concession or through an availability contract, that allocate the demand risk differently. During the building and the management stages, the private firm may undertake some efforts impacting the quality of the service and its costs. For example, the private operator can find a way to train his maintenance teams more rapidly but less efficiently, which might have a negative effect on safety for users. Or he

[1]Source: www.cre.fr/reseaux/reseaux-publics-d-electricite/description-generale
[2]www.appr.com/fr/amenagement-reseau/Bilan-LOTI-A77-LOTI-2-Synthèse.pdfFileID=pdf%2FBilan-loti-a77-loti-2-synthesese.pdf

can make some efforts to improve his internal processes so as to provide better quality services. The outcomes of these efforts[3] are assumed to have an observable but unverifiable effect on quality. Then, we determine the incentives the private party gets to make such non-contractible investments, under each type of contractual agreement: availability contracts and concession contracts.

We depart from Hart [2003] in three ways. First, we consider a good or service that can be excludable. In other words, the infrastructure may be refunded by users payment, as in concession contracts, or it may be refunded thanks to payments by the public authority (and *in fine* by taxpayers), as in availability contracts. Second, we introduce an aggregated social benefit function, so that the number of users determines the total social benefit generated by the public service. Third, in accordance with the literature that underlines unsatisfactory *ex post* changes (Williamson [1999]), we introduce the possibility that the private operator makes *ex post* investments for which the adverse effect on quality for users is higher than the gains for the private operator.

Our results show that the choice between concession and availability contracts has two separate impacts: first, this choice impacts the economic performance of the service to deliver, because it entails different incentives for the operator to invest during the execution of the contract. These incentives are closer to the optimal ones under concession contracts compared to availability contracts, because new investments may attract new users and then increase the operator's revenue. Second, the choice of the contractual arrangement impacts the conditions under which the citizens access the service: concession contracts limit this access because of the fee required by the operator to use the service. On the opposite, access is free under availability contracts. This may raise equity concerns for the public authority, and those concerns may be related to the social norms of a given society, *i.e.* to part of its institutions.

This paper contributes to the literature on public-private arrangements. Many papers (Hart [2003], Bennett and Iossa [2006], Martimort and Pouyet [2008], Hoppe, Kusterer, and Schmitz [2011]) have explored the question of bundling or unbundling, and they implicitly focus on the case when payment by users is not possible: the public authority pays a fixed price to one or two private operator(s) to have a facility built and operated. They show that the main interest to bundle tasks is to exploit synergies between the different stages of a project, inducing more innovative and cost-effective designs (Treasury [2003]). In this paper, bundling of construction and operation stages is taken for granted, and our concern is to analyze the effect of the demand risk transfer to the operator on the users' well-being, which has not yet been studied in the literature to our knowledge.

Although concession contracts are frequently observed in energy, water, and transport sectors[4], they have not attracted much attention in the economic literature. However, let

[3]In the incomplete contract theory, the outcome of an effort is indifferently called "investment" or "innovation".

[4]Source: World Bank, PPIAF, PPI Project Database and EPEC Market update 2010.

us note that Auriol and Picard [2011] compare concession contracts to public provision. They highlight a trade-off between the cost of public funds due to government's financial pressure (under public provision), and allocative inefficiencies due to private information on costs and leading to excessive usage prices (under concession contracts). In this paper, we depart from this analytical framework in order to focus on the consequences of two types of public-private partnerships (concession and availability contracts) on economic performance (through the incentives to innovate during the execution of the contract), and on equity considerations (through the access of the citizens to the service). Last, Engel, Fischer, and Galetovic [2011] analyze the consequences of risk demand transfer from a public finance perspective. Our paper is related to theirs by focusing on the allocation of the demand risk, but we depart from them by stressing the impact of this allocation on quality and access to the service rather than public budget considerations.

The paper is organized as follows: next section describes the two typical bundled contractual public-private arrangements, concessions and availability contracts, and provides some examples of *ex post* investments the private operator may undertake. Section 3 describes the framework of the model, while section 4 derives and analyzes the incentives of private operators to implement investments that have an impact on quality, for each type of contractual arrangement. In section 5, we discuss the appropriateness to use availability contracts or concession contracts. Finally, section 6 concludes and provides some public policy recommendations.

2 Public-private arrangements for infrastructure-based services

2.1 Concessions and availability contracts: some elements of description

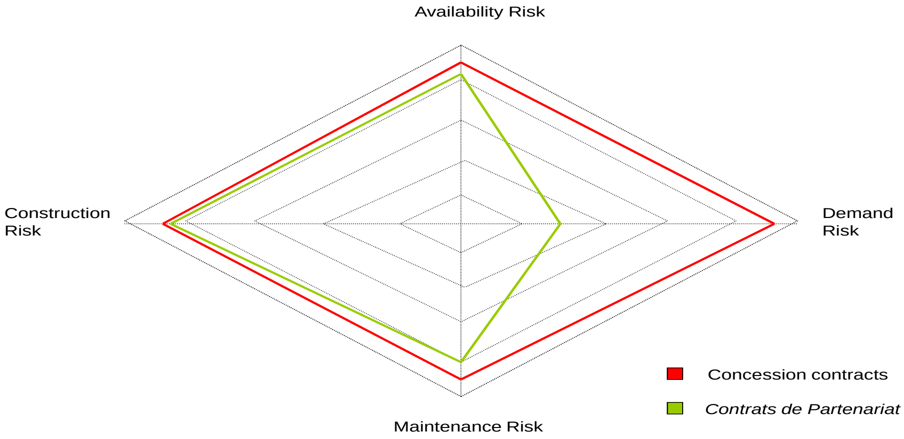
Concession contracts and availability contracts belong to the generic family of public-private partnerships. This section provides a brief recall of these two main bundled types of public-private partnerships, *i.e.* for which both the building and the management of the infrastructure are made by one operator (in a single contract).

Under concession contracts, the main characteristic is that the private firm is remunerated through the fees paid by users: the operator holds the right to the cash-flow of the users' receipts from the service. As a consequence, profits "depend on the utility's sales and costs, which typically gives the operator incentive to improve operating efficiency and increase sales" (World Bank [2006]). Thus, under such types of agreements, commercial risk is transferred to the private partner, as his ability to derive a profit is linked with its ability to reduce operating costs and attract users, while still meeting designated service levels (European Commission [2003]). During the execution of contracts, the private operator cannot decide unilaterally the increase of the fee, so that the leverage of action for the private operator to increase his revenue is to search for some ways to decrease his costs or to attract more users.

Following the Private Finance Initiative (PFI) initiated in 1992 in the U.K., many countries have adopted availability contracts that are a new type of contractual agreement allowing to contract out the design, finance, building, operation and maintenance of an infrastructure. As in concessions, all tasks are bundled and contracted-out to one private operator. But the difference with concession contracts is that the payment of the private operator is made through a fixed price paid by the public authority, and users have no fee to pay.[5] In concessions, the revenue of the operator depends on users' demand and their willingness to pay, whereas in availability contracts, the operator gets his revenue, whatever the frequenting of the infrastructure and users do not pay for the use of the infrastructure (Tessier [2004]). In this way, the operator does not bear the demand risk, he is only exposed to the building, availability and maintenance risks, as shown by Figure 1. The public authority specifies *ex ante* the required objectives, *i.e.* a basic service standard, and the payment of the fixed price depends on the satisfaction of the contractible objectives.

[5]Some mixed solutions where there is a payment by users in availability contracts exist. This payment may be collected by the private operator and transferred to the public authority (Article 1 of the Law n° 2008-735, July 28th 2008 in France). Another solution consists in implementing a "shadow toll": users do not pay any fee, but the payment of the operator by the public authority depends on the frequenting of the infrastructure. In this case, the demand risk is borne by the private operator. We disregard these intermediary solutions, but we are aware of their existence. As the object of this paper is to study the advisability of transferring the demand risk or not, we are compelled to distinguish clearly the two polar cases. Future works could consist in studying further contractual refinements.

Figure 1: Representation of the risks transferred to the private operator in concession and in availability contracts



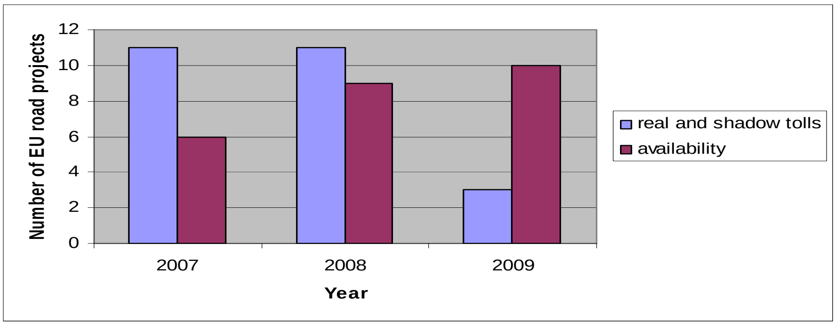
Source: Institut de la Gestion Déléguée, 2006

One could think that concession contracts and availability contracts are used for distinct projects, and more precisely that availability contracts are chosen when the receipts from users are not possible (as in prisons for instance). However, it appears that concession and availability contracts are increasingly used for similar types of projects. For instance, the high speed line signed in 2011 to join *Tours* and *Bordeaux* in France is a concession, while the highspeed line that will join *Le Mans* and *Rennes* (that are two other French cities) will be an availability contract. Yet, all these four cities belong to the first thirty urban areas in France. The population in *Tours* and *Bordeaux* is quite equivalent to *Le Mans* and *Rennes*.[6] And the length of the rail projects are of a similar scale: 302 kilometres for *Tours-Bordeaux* and 214 kilometres for *Le Mans-Rennes*.

Another illustration is given in figure 2 about contracts signed for road projects in the European Union. These EIB data concern 50 EU road projects (including bridges and tunnels) signed between 2007 and 2009. We observe real and shadow toll contracts (in which the private operator bears the demand risk) as well as availability contracts for these projects. Availability contracts increase over the years.

[6]The 2008 census report states that there are 135 000 inhabitants in *Tours*; 235 000 in *Bordeaux*; 143 000 in *Le Mans*; and 207 000 in *Rennes*.

Figure 2: Demand risk allocation in EU road contracts between 2007 and 2009



Source: European Investment Bank

To explore the consequences of the allocation of the demand risk, the following paragraph shows how quality considerations may give part of the answer.

2.2 The quality issue in public-private partnerships

The quality of public services and goods has strong consequences on the economic growth (Barro [1990]). However, quality requirements cannot be extensively described in the contracts, which explains the fear of public authorities that private operators could sacrifice the quality of service, in the name of profitability. Let us recall the different ways to consider quality aspects of a service in the economic literature.

First, some quality aspects can be contracted-on *ex ante*, in the initial contract. A third party can verify these features, so that there is no problem of contractual incompleteness. Second, there are some other quality aspects that cannot be written *ex ante* (because they would not be verifiable), but the impact of *ex post* investments on such quality aspects becomes verifiable, so that it is frequent that parties renegotiate the contract to implement investments aiming at improving quality. For instance, Hart, Shleifer, and Vishny [1997] and Bennett and Iossa [2006] focus on these investments that are noncontractible *ex ante* but verifiable *ex post*. These aspects imply that *ex post* renegotiations occur to get the approval of the owner of the facility.

Finally, some other quality aspects cannot be written *ex ante* (because they would not be verifiable), and they are still not verifiable *ex post*. Hence, the private operator can decide alone to implement or not investments that have an unverifiable impact on quality. These latter are the most worrisome since the public authority cannot monitor their implementation through a renegotiation process. As in Hart [2003], our focus in this paper is on these investments that have an unverifiable impact on cost and quality. Depending on the incentive structure the operator has, he may be willing to leave aside the issue of quality, and users may suffer from this lack. Let us describe examples of such unverifiable investments. We observe that they do not have the same effect on quality and on the cost for the private operator.

- A CHANGER : Hart [2003] [page C72] quotes the example of a builder of a prison that might realize during the process of building that he can install an electric fence that reduces the likelihood of escapes. This reduces the operating costs of the prison, since fewer guards have to be hired, but this may not have the expected safety effect, and may be not what the government had in mind.

- Fortunately, seeking for lower costs does not necessarily have negative impacts on quality: In 2010, managers of the french operator *VINCI* decided to solve a problem of inefficiencies due to a lack of knowledge transmission, by writing a handbook with the guidelines and best practices in *VINCI* programme management and to update it through a web platform where the different employees could exchange their experience. Thus, this unverifiable organizational innovation may have the effect **to decrease cost as well as to increase quality**.

- Other examples show that efforts may also aim **at increasing quality and reducing costs**, as the technological innovation that is currently developed by the private operator of the R1 Slovak highway. A smart phone application will shortly provide real time information about weather conditions, especially to know where and how slippery the road surface is. This will increase safety for users, as well as it will decrease the number of interventions by breakdown lorries supported by the operator.[7]

- Last, some efforts aim at **increasing quality**. An innovation that appeared in 2010 in the car park sector related to unpleasant smells. A car park operator created a diffuser of liquid and antisceptic smell destruction that automatically detects the presence of bad smells. This innovation improves quality **but it also increases costs**. This diffusor was nominated for the regional innovation award of the 2011 VINCI innovation award.[8]

These examples of uncontracted-for and unverifiable qualitative features show that quality is a major concern for long-term public-private contracts. In next sections, we investigate the incentives private operators have to improve quality or reduce their costs, depending on the contract that is signed.

[7] Source: www.pr1bina.sk
[8] Source: www.vincipark.com

3 The framework of the model

3.1 The basic assumptions

Our theoretical framework is based on Hart [2003]. Let us note G, a benevolent public authority (whom we refer to as "she"), in charge of delivering and managing a public infrastructure. We consider a setting where G delegates to a private firm the building and management of an infrastructure which is used to supply a public service. The facility construction and its operation are bundled. This implies that G contracts with a single private party[9] to build and run the facility. In this case, the private party can either be paid by G through a fixed price (availability contract), or can directly collect fees from users (concession contract). We assume that all parties are risk-neutral. As usual in the literature on bundling, there is no discounting. Moreover, we assume that the public authority is able to write contracts, specifying some aspects of the facility to be delivered or the basic service to be provided.

In addition, our assumption is that in each case the contract is incomplete in the sense that the operator can implement investments during the execution of the contract that lead to modify the service, without violating the contract. The operator can make two types of investments which are not contracted upon and that have an impact on quality: e and i. They have consequences for the costs and benefits of running the facility.

- i is a non-verifiable investment that increases the quality of service for users, but it also impacts costs to run the facility: i may increase or decrease the operation costs.
- e is the non-verifiable investment that enables to decrease the costs, but may also have the consequence to improve or undermine the quality of service.

Throughout the paper, we speak of e and i interchangeably as "innovation" or "investments". As in Hart [2003], these investments are never verifiable, which does not allow for *ex post* renegotiations between the parties.

Then, the total *ex post* cost function for the building and operation stage is:

$$C = K^0 + C^0 - c(e) - \gamma.v(i) + e + i$$

where K^0 is the contractible cost of construction of the infrastructure, and C^0 is a positive constant representing the contractible cost to run the service.[10]

[9] When tasks are bundled, the private party is often a consortium of two firms or more, in PFI as well as in concession contracts. But what matters is that, although the operator may have several sub-entities, the private operator is the single interlocutor of the public authority.

[10] In the literature that analyzes the question of bundling vs. unbundling, there are generally two cost functions (Hart [2003], Bennett and Iossa [2006]): one for the building stage, and one for the operation stage. Describing two functions enables to compare the consequences to bundle or not the service. This is not relevant in our framework, since we take the bundling decision for granted.

- When $\gamma = -1$, there is a negative impact of the quality enhancing innovation on costs: the investment i increases the social benefit (the quality) of the service, but entails greater operation costs. The example of the car park liquid diffusor of smell destruction described in section 2 corresponds to that case.

- When $\gamma = 1$, the externality is positive: the quality enhancing investment i reduces operation costs. The innovation found by the Slovak highway operator suits this situation.

We assume that $v(0) = 0$, $v'(i) > 0$, $v''(i) \leq 0$, if $\gamma = 1$; and $v(0) = 0$, $v'(0) = 0$, $v''(i) \geq 0$ if $\gamma = -1$.

As for e, it represents the non-contractible investment the operator may make and $c(e)$ is the operation cost reduction implied by this effort; $c'(e) > 0$, $c''(e) \leq 0$.
We assume here that the cost to operate the service does not depend on the number of users: for instance, whether an additional driver uses the highway or not does not change the cost to maintain the highway. In the same way, the operational cost of a stadium does not vary a lot whether an additional spectator is present or not.[11]

We depart from Hart [2003] by introducing an aggregated social benefit function. The (unverifiable) social benefit of the service (expressed in money) is:

$$B = D \times [b_0 + \beta(i) + \phi b(e)]$$

where $D \geq 0$ is the demand (*i.e.* the quantity of users) for the service, b_0 is a postive constant, representing the (contractible) social benefit (as described in the initial contract) for each user of the service.
The quality increase due to investment i is represented by $\beta(i)$. We assume that $\beta'(i) > 0$, $\beta''(i) \leq 0$, which implies that an increase in quality of the facility increases the social benefits from the provision of the service.
The impact of investment e (*i.e.* the investment that reduces costs) on the quality is determined by the value of ϕ.

- When $\phi = +1$, this means that the investment to reduce costs during the management stage also allows to increase the social benefits of the service. This is the example of the organizational innovation described in subsection 2.2. In this case, $b'(e) > 0$, $b''(e) \leq 0$. The investment is a "productive" investment that makes the service less costly and easier to run or more attractive.

[11]This does not mean that there is no threshold in the cost function as regards to the number of users: a highway used by thousands of drivers may be more expensive to maintain than a highway used by few drivers. However, costs vary by levels and not for each additional user. In other words, the marginal cost to maintain a public service is zero. This is not the case of the social benefit function as described below: each new user enjoys some benefits by using the service.

- Alternatively, when $\phi = -1$, the cost reduction creates an adverse effect on the quality. In such a situation, we assume that $b'(e) > 0$, $b''(e) \geq 0$. Such a situation occurs for instance when the cheaper maintenance of a highway increases the risks of car crash.

Whatever the investments e and i, we assume that $b_0 + \beta(i) - b(e) > 0$: the service still procures a minimal social benefit to the citizens. However, we allow here for inefficient investments: the investment i creates some social benefits $\beta(i)$ but also generates costs $v(i)$ if the cost externality is negative. This cost increase may be lower than the social benefits ($\beta(i) \geq v(i)$) or higher ($\beta(i) \leq v(i)$). In the same way, when the cost reduction innovation creates some adverse effects ($\phi = -1$), this adverse effect may be lower ($b(e) \leq c(e)$) or higher ($b(e) \geq c(e)$) than the cost reduction.

3.2 The demand for the public service

We assume that the maximum potential demand for the service is $\bar{D}$, with $\bar{D} \geq 1$. Then, $\bar{D}$ represents the highest number of users that *could use* the facility.[12] However, we distinguish this maximum demand and the realized demand that is made up of the *real* number of citizens using the service. This number depends on the decision of the citizens to use or not the service, and this decision is made as regards to the fee they have to pay and to the quality of the service. For instance, a well-constructed and maintained highway may attract more users than a bad-quality highway. In other words, because citizens make a cost/benefit analysis to decide to use the service or not, any variation in quality leads to a variation in the number of users of the service.
The maximum level of realized demand that can be reached is $\bar{D}$, and corresponds to the optimal level of demand.
We denote $D^f (\leq \bar{D})$ the realized demand for a fee f the users have to pay to access the service.

To make things simple, we consider a linear demand function so that $D^f = D_0(f) + d^f(\beta(i) + \phi b(e))$, where:

- $D_0(f)$ is a positive function that represents the "basic" demand for a service that costs f and procures an individual benefit b_0. Then, $D_0(f)$ represents the quantity of users that are ready to pay f to get b_0. This function is decreasing in f ($D_0'(f) < 0$): the higher the fee is, the fewer citizens are ready to pay f to get a constant benefit b_0. The function $D_0(f)$ must be understood as the initial quantity of users who access the service or infrastructure. Then, the higher the price, the lower the required quantity. We assume that when users have no fee to pay, as it is the case under availability contracts, the demand is at its maximum, *i.e.* $D_0(0) = \bar{D}$. Since the payment of

[12] When $\bar{D}$ is reached, it is not extensible.

the private operator is made through a fixed price that is paid through taxes by all citizens, whether they use the service or not, the cost to use the service is a sunk cost. All taxpayers (whether users of the facility or not) pay for the service, and there is no additional fee required to become a user ($f = 0$).

- $d^f \in (0, 1)$ represents the elasticity, or more precisely, the coefficient of sensitivity of the demand (for a fee f) to the quality variation of the service.[13] Any quality variation $(\beta(i)+\phi b(e))$ leads to a variation in the number of users equals to $d^f(\beta(i)+\phi(b(e)))$.[14] If $d^f = 0$, the demand does not depend on the variations in quality of the service. On the opposite, if $d^f = 1$, the demand is highly sensitive to the quality.[15]
  When $f = 0$, then whatever the quality variations, the service still brings a benefit since we assume that $\forall(e, i)$, $b_0 + \beta(i) + \phi b(e) > 0$. In this case, marginal quality variations have no impact: $d^f = d^0 = 0$.

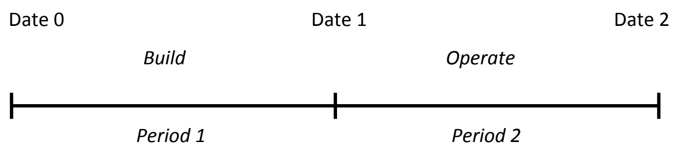
Moreover, whatever the quality variations, the service still brings a benefit since we assume that $\forall(e, i)$, $b_0 + \beta(i) + \phi b(e) > 0$. Then, when $f = 0$, marginal quality variations have no impact ($d^f = d^0 = 0$).

3.3 The timing of the game

The timing of the game is as follows:

- The public authority and the operator contract at date 0 and the facility is built between dates 0 and 1.
- The facility is operated between dates 1 and 2 (to provide the public service).

Figure 3: Timing of the game



[13]There is no over-reaction so that $d^f \leq 1$.

[14]We can detail the cost/benefit analysis of the citizens to decide whether to use the service or not: the individual cost for users is f (the fee required to use the service) and the individual benefit (as described in the contract) is b_0. Because of innovations e and i, this individual benefit may vary from an amount $\beta(i) + \phi(b(e))$. Then, this change in benefit leads to a change in the cost/benefit analysis of each user, and influences their decision to use or not the service.

[15]$d^{f'} = 0$ because it is a coefficient.

- At **date 0**, the type of contractual agreement (availability or concession contract) is chosen, and the public authority specifies the basic standards of the service to be provided. These basic standards are observable and verifiable. The parties also write in the contract the prices that will be applied during the whole contract lifespan: under availability contract, the price P that will be paid to the operator by the public authority, provided that the verifiable objectives are reached[16]; under concession contract, f, that is the fee to apply to the users of the service. P and f are determined by the *ex ante* competition (under which the operator is selected).[17]
- In **period 1**, between date 0 and date 1, the facility is built.
- In **period 2**, between date 1 and date 2, the facility is operated, and citizens may use it.

Either in period 1 or in period 2, the operator can implement investments e and i as described in subsection 3.1.

3.4 The first-best level of investments

Let us first determine the optimal levels of investment that maximize the total surplus of all the potential demand $\bar{D}$. The first-best incentives to invest are those maximising the benefits minus all the costs if the contract was complete, *i.e.* if the investments e and i were contractible:

$$max_{e,i}\bar{D}(b_0 + \beta(i) + \phi b(e)) - K^0 - C^0 + c(e) + \gamma v(i) - e - i$$

In first-best, we consider that the whole demand is satisfied. Thus, the optimal levels of investments i^{FB} and e^{FB}, are the following:

$$\bar{D}\beta'(i^{FB}) + \gamma v'(i^{FB}) = 1 \quad (1)$$
$$c'(e^{FB}) + \bar{D}\phi b'(e^{FB}) = 1 \quad (2)$$

The first-best total surplus is :

$$S^{FB} = \bar{D} \times (b_0 + \beta(i^{FB}) + \phi b(e^{FB})) - C^0 - K^0 + c(e^{FB}) + \gamma v(i^{FB}) - e^{FB} - i^{FB}$$

[16] We implicitly assume here that these verifiable objectives are reached and that the private operator gets P under availabiliy contracts. As explained in section 2, our focus is on unverifiable investments and not on verifiable measures of performance that have already drawn some economic literature (?Laffont and Martimort [2002]).

[17] We consider that the operator is selected through a competitive tendering, whatever the type of contractual agreement. This allows to introduce competition *for* the market (Demsetz [1968]). We do not provide here any institutional detail about how this competitive tendering process occurs, but we simply consider that the selection process is a competitive one.

4 Incentives to innovate under each type of contract

4.1 Availability contracts

As reminded previously, the building and the management of the facility are bundled. The contract that is signed at date 0 specifies the basic service to deliver between date 1 and date 2, at a competition price P. The operator chooses the investment levels e and i that maximize his payoffs. As the operator is not constrained by users' behaviour (he will be paid his fixed price as soon as the required contractible quality standards are verified, and whatever the frequenting of the infrastructure), he only takes into account the effects on costs in his uncontractible investment strategy. As a consequence, the operator maximizes the fixed price he receives minus his costs:

$$\max_{i,e} P - C^0 - K^0 + \gamma v(i) + c(e) - e - i$$

Therefore, the incentives under availability contracts are e^A and i^A such as:

$$c'(e^A) = 1 \tag{3}$$

$$\gamma v'(i^A) = 1 \tag{4}$$

Note that if there is a negative cost externality ($\gamma = -1$) of investment i, there is a corner solution, so that $i^A = 0$. By extension, inefficient innovations i that entail more costs than benefits are never implemented.
The private party only invests in i^A when it can reduce his operation cost ($\gamma = +1$). Moreover, the social impacts of innovations are never integrated, since the control rights are private and the innovations can be implemented without the approval of the public authority.
Thus, the operator does not take into account the adverse effect on quality when he invests to reduce the operation cost. As a consequence, he may implement inefficient innovations e that create more adverse effect ($\phi b(e)$ when $\phi = -1$) than cost reduction ($c(e)$) because he does not suffer from this adverse effect (through a lower use of the infrastructure implying lower revenues) and only benefits from the cost reduction.

Comparing the first-order conditions (3) and (4) to the equations (1) and (2) defining the first-best levels of investments, we can establish that:

- $\forall \gamma = \{-1; 1\}$, $i^A < i^{FB}$
- When $\phi = -1$, $e^A > e^{FB}$
- When $\phi = +1$, $e^A < e^{FB}$

In other words, under availability contract, the operator over-invests in cost-reducing investment e^A when there is a negative externality on quality, but he under-invests when the externality is positive. He also under-invests in quality-enhancing innovations whatever the externality on costs.

Result 1. *In availability contracts, the operator under-invests in quality improving efforts i since he does not internalize the positive social effect of his investment, but only the effect on costs. When* $\gamma = -1$*,* $i^A = 0$*. As regards investment e, the operator over-invests in e when* $\phi = -1$*, since he does not internalize the adverse effect on quality. Finally, he under-invests in e when* $\phi = +1$ *since he does not inernalize the positive effect of his investment on quality.*

Since there is no access fee, the initial demand is at its maximum ($D^A = \bar{D}$), and $d^f = 0$

Thus, the payoff of the public authority is $UG = \bar{D}(b_0 + \beta(i^A) + \phi b(e^A)) - P(1+z)$; where $z \geq 0$ is the cost of public funds. As in Laffont and Tirole [1993], the government's financial constraint is summarized by its shadow cost of public funds, which measures the social cost of its economic intervention. Every euro or dollar spent by the public authority implies an increase in distortionary taxation or costly public debt. As recalled by Auriol and Picard [2011], this shadow cost is usually high in developing countries that face structural difficulty in raising taxes. It is also very much likely to have drastically risen in many developed economies that face severe budget deficits since the 2008 financial crisis (e.g. Greece, Spain, Portugal, Ireland, France, the UK, and the US).
The surplus reached under availability contracts is:

$$S^A = \bar{D}(b_0 + \beta(i^A) + \phi b(e^A)) - C^0 - K^0 + c(e^A) + \gamma v(i^A) - e^A - i^A - zP$$

4.2 Concession contracts

4.2.1 Incentives to innovate under concession contracts

Under concession contracts, the private operator still holds the control rights but he is paid through the fees he collects on users. We assume that the fee is the result of a perfect price competition, and that this fee does not evolve during the lifespan of contracts. Making the infrastructure being refunded by users allows to save on the cost to raise public funds. Before determining the levels of incentives the private operator has to invest in quality and in cost savings, let us first analyze his revenue function.
In concession contracts, the global revenue of the private operator depends on the demand for the service, since each user pays the operator this fee f. During the execution of the contract, the total demand for the service is then:

$$D^f = D_0(f) + d^f \times \beta(i) + d^f \times \phi b(e) \text{ subject to } D^f \leq \bar{D}$$

The revenue of the operator becomes:

$$f \times [D_0(f) + d^f \beta(i) + d^f \phi b(e)]$$

Then, variations in quality lead to variations in the revenue of the operator. Let us detail these variations:

- $f \times d^f \times \beta(i)$ represents the additional revenue due to an increase in the number of users, thanks to a better quality ($\beta(i)$), with $d^f \geq 0$. The higher the quality increase of the service, the more numerous users are, and the higher the additional revenue is. We add another assumption: the additional revenue from an increase in quality cannot be superior to the quality increase itself: $f \times d^f \times \beta(i) \leq \beta(i)$. For instance, a better smell in a cark park may not be valorized by all users, so that it does not always induce more using of the car park, hence the additional revenue may be lower than the social value of the quality increase.

- $f \times d^f \times \phi b(e)$ represents the amount of revenue that can be lost (gained) because of an investment e to reduce costs that has a negative (positive) impact on quality, and that induces less (more) using of the service. The higher the damage on quality, the higher the loss of revenue is. As in the previous case, we assume that the loss of revenue (it is the case when $\gamma = -1$) can be as high, but not higher than the total damage, $0 \leq f \times d^f \times \phi b(e) \leq b(e)$. A loss of revenue that is inferior to the quality damage means that all users have not valued the loss of quality identically, so that the revenue loss does not reflect the whole quality damage.

Let us now analyze the incentives of the operator to consider the impact of quality. The operator implements investments so as to maximize his payoff function, which contrary to availability contracts, includes the social effect of the uncontracted-for investments since they can have an impact on his revenue, until the demand reaches its maximum level $\bar{D}$. As a consequence, the levels of incentives to innovate maximize:

$$\begin{aligned} \max_{i,e} \quad & f \times [D_0(f) + d^f \times \beta(i) + d^f \times \phi b(e)] - K^0 - C^0 + c(e) + \gamma v(i) - i - e \\ & s.t.\ D_0(f) + d^f \times \beta(i) + d^f \times \phi b(e) \leq \bar{D} \end{aligned}$$

The lagrangian function of this maximization program is:

$$\begin{aligned} L = \quad & f \times [D_0(f) + d^f \times \beta(i) + d^f \times \phi b(e)] - K^0 - C^0 + c(e) + \gamma v(i) - i - e \\ & + \lambda(\bar{D} - D_0(f) - d^f \times \beta(i) - d^f \times \phi b(e)) \end{aligned}$$

where $\lambda \geq 0$ is the lagrangien multiplier.

The levels of investments e^C and i^C under concession contract are implicitly given by:

$$c'(e^C) + d^f \times \phi b'(e^C)(f - \lambda) = 1 \tag{5}$$
$$d^f \times \beta'(i^C)(f - \lambda) + \gamma v'(i^C) = 1 \tag{6}$$

Then, the incentives of the private operator to invest depend on f, d^f and λ:

- d^f represents the coefficient of sensitivity of users to the quality of the service for a fee f.
- f represents the amount of the fee charged per user on the total revenue of the operator. Let us remind that the fee remains fixed during the execution of the contract.
- λ is the lagrangian multiplier that can be interpreted as the influence of the demand constraint on the incentives to invest. If the constraint does not bind ($\bar{D} - D^f > 0$), then $\lambda = 0$: any variation in quality leads to a variation in the number of users, and then in the revenue of the operator. Then, the operator internalizes the consequences of the innovations on quality up to the impact on his own revenue, *i.e.* up to $f \times d^f$: the marginal revenue that can be gained (lost) thanks to an increase (decrease) in quality.
  If the constraint binds ($\bar{D} - D^f = 0$), the demand is at its maximum level and $\lambda > 0$. In this situation, the operator has fewer incentives to increase quality through innovation i (except if $\gamma = +1$) because the demand is already at its maximum level, so no additional user can be attracted by an increase in quality.[18] However, the operator cares about the adverse effect caused by cost reduction (*i.e.* if $\gamma = -1$) when the constraint binds, since any decrease in quality entails a decrease in the number of users. In other words, the demand will no longer be at the maximum level if the innovation due to effort e^C creates a damage on quality.

In a way, d^f and λ are two dimensions of the degree of captivity of users.

Result 2. *Contrary to availability contracts, in concession contracts, the private operator has incentives to take quality into account when the demand constraint does not bind and when users are sensitive to quality variations. The incentives to invest in cost reduction (e) and quality increase (i) depend on the fee collected on users and on the sensibility of users to quality variations (d^f).*

[18] We consider that f is big enough so that for all λ, $f - \lambda \geq 0$. If $(f - \lambda) < 0$, this would imply that the operator has negative incentives to increase quality, and would try to decrease it (even if it generates no monetary profit through cost reduction). Then, $(f - \lambda) < 0$ is a theoretical result, but has no convincing interpretation in our case, so that we rule out this possibility.

For any $f > 0$, the surplus under concession contract becomes:

$$\begin{aligned} S_f^C &= D^f \times (b_0 + \beta(i^C) + \phi b(e^C)) - C^0 - K^0 + c(e^C) + \gamma v(i^C) - e^C - i^C \\ &= [D_0(f) + d^f \beta(i^C) + d^f \phi b(e^C)] \times (b_0 + \beta(i^C) + \phi b(e^C)) - C^0 - K^0 + c(e^C) \\ &\quad + \gamma v(i^C) - e^C - i^C \end{aligned}$$

4.2.2 Demand risk and Incentives to innovate

Let us note that when the users are not sensitive to quality variations ($d_f = 0$) or when all the potential users already use the service ($D_f = \bar{D}$), equations (5) and (6) are the same as equations (3) and (4). In these situations, the operator under concession contracts does not get higher incentives to innovate than under availability contracts, since these efforts would not entail higher revenues for him. This may explain why concession contracts sometimes achieve a lower quality level than expected, as illustrated in the example given in introduction about the French electricty market, where the firm ERDF operates under a concession contract. Indeed, there is no alternative in the french electricity market than to use ERDF to distribute electricity, so that the demand is captive and the operator has low incentives to improve its quality.
As a consequence, the transfer of the demand risk to a private operator changes the incentives to innovate only if (i) the users have credible alternative options than to use the service, and if (ii) they have some concerns for quality improvements.

4.2.3 The role of the fee under concession contracts

Equations (5) and (6) show that incentives to innovate under concession contracts mainly depend on the level of the fee f, and on the sensibility of the users to quality variations (d^f).

Let us now analyze the impact of the fee. Because of the *ex ante* competition to select the private operator, the fee is a “competitive price” such that the profit of the private contractor is equal to zero. Then, the competition fee[19] is such that:

$$UM^C = f \times (D_0(f) + d^f \beta(i^C) + d^f \phi b(e^C)) - C^0 - K^0 + c(e^C) + \gamma v(i^C) - e^C - i^C = 0$$

In the end the concession surplus is impacted by the level of the fee in a double way:

- Appendix 1 shows that incentives i^C and e^C are increasing in f. The higher the fee, the more attention the private operator pays to innovations, since those innovations

[19] Let us note that this competition fee is not necessarily the one that maximizes surplus of the concession contract. The fee that would maximize the concession surplus is given by:

$$max_f S^C \Leftrightarrow$$
$$max_f[(D_0(f) + d^f \beta(i^C) + d^f \phi b(e^C)) \times (b_0 + \beta(i^C) + \phi b(e^C)) - C^0 - K^0 + c(e^C) + \gamma v(i^C) - e^C - i^C]$$

may have a high incidence on the number of users and on the revenue of the private operator, if users are sensitive to quality variations.

- However, a high fee also means that the initial demand $D_0(f)$ is low since users need to pay a high price to access the service: $D_0'(f) \leq 0$.

5 Concession or Availability contract: what choice?

In this section, we compare the incentives and the total surplus reached under each contractual agreement. We also discuss the implications of these results.

5.1 Comparison of the incentives under each type of contractual arrangement

In order to rank the contractual arrangements in the light of the incentives given to the operator to take care of quality, we remind in the following table the incentives that are reached:

Table 1: Levels of incentives to make investments e and i

	First Best	**Availability Contract**	**Concession**
Invt. i	$\bar{D}\beta'(i^{FB}) + \gamma v'(i^{FB}) = 1$	$\gamma v'(i^A) = 1$ if $\gamma = 1$ & $i^A = 0$ if $\gamma = -1$	$d^f \times \beta'(i^C)(f-\lambda) + \gamma v'(i^C) = 1$
Invt. e	$c'(e^{FB}) + \bar{D}\phi b'(e^{FB}) = 1$	$c'(e^A) = 1$	$c'(e^C) + d^f \times \phi b'(e^C)(f-\lambda) = 1$

From the first-order conditions[20] (3), (4), (5) and (6), we can compare the incentives to invest in concession and availability contracts:

- Whether $\gamma = +1$ or $\gamma = -1$, $i^A < i^{FB}$ and $i^A < i^C$
- When $\phi = +1$, $e^A < e^{FB}$ and $e^A < e^C$
- When $\phi = -1$, $e^A > e^{FB}$ and $e^A > e^C$

Appendix 2 shows that the incentives to invest in quality under concession contracts are under-optimal, while incentives to invest in cost are suboptimal when $\phi = +1$.

[20]Remember from section 3.1., the concavity and convexity of functions v and b vary with the sign γ and ϕ. Notably, b is concave when $\phi = 1$ and b is convex when $\phi = -1$. v is concave when $\gamma = 1$ and v is convex when $\gamma = -1$.

Proposition 1. *Both the concession and the availability contract arrangements lead to underoptimal levels of incentives to increase quality. However, the concession arrangement entails higher incentives than availability contracts, since the private operator internalizes the effect of his investments on users' reaction.*

At this stage, the intuition according to which concession contracts lead to better incentives to innovate than availability contracts is verified. Let us now compare the total surplus under each contract.

5.2 Comparison of the surplus

The concession contract is preferable to the availability contract if it leads to a higher surplus, *i.e.* if:

$$S_f^C \geq S^A \Leftrightarrow$$
$$D^f \times (b_0 + \beta(i^C) + \phi b(e^C)) - C^0 - K^0 + c(e^C) + \gamma v(i^C) - e^C - i^C >$$
$$\bar{D}(b_0 + \beta(i^A) + \phi b(e^A)) - C^0 - K^0 + c(e^A) + \gamma v(i^A) - e^A - i^A - zP$$

$$\Leftrightarrow c(e^C) - c(e^A) + \gamma v(i^C) - \gamma v(i^A) - e^C - i^C + e^A + i^A > \quad (7)$$
$$\bar{D}(b_0 + \beta(i^A) + \phi b(e^A)) - D^f \times (b_0 + \beta(i^C) + \phi b(e^C)) - zP \quad (8)$$

The term (7) of the previous inequation represents the difference in incentives to innovate under concession contracts and availability contracts, while the term (8) is the loss in the number of users under concession contracts compared to availability contracts. Then, a concession contract is preferable if it allows to gain more (as regards to incentives to innovate) than the loss it entails (*i.e.* the limited access to the service because of the fee to pay).

Let us note that the higher the difference between $\bar{D}$ and D^f is (which depends on the initial demand $D_0(f)$ and on the sensitivity of users to quality variations d^f), the less preferable concessions are. Moreover, the lower $D_0(f)$ the higher the difference in terms of quantity of demand between concession and availability contracts. Thus, public authorities have to pay particular attention to $D_0(f)$ to determine their contractual choice:

- If the initial demand $D_0(f)$ is not too affected the level of the fee, then it is likely that the concession arrangement leads to a higher surplus than the availability contract arrangement and thus, it is preferable. The higher incentives to invest under concession contract make them more performant.

- If $D_0(f)$ is mainly determined by the level of the fee, then the availability contract is preferable, since it may lead to a higher surplus. Fewer users are excluded because of the fee. This favors equity between citizens. In this case, the incentive effect of concession contracts does not outweigh the impact on the initial demand.

Proposition 2. *The comparison between availability contracts and concession contracts boils down to a trade-off between economic performance (through high incentives to innovate) and equity concerns (through a larger access to the public service).*

Let us now interpret this result. The sensitivity of the initial demand $D_0(f)$ to the level of the fee may be different from one country or region to another due to social, cultural or economic reasons (poverty of the population, political acceptability of the fee).[21] One cannot conclude that the concession arrangement is intrinsically a better solution than the availability contract arrangement, since there is a trade-off between affordability for users, leading to a certain quantity of demand (equity), and incentives to improve or protect quality (performance): the choice must depend on the local conditions, and on political considerations (whether the public authority prefers to enlarge the access to public services, or prefers to develop innovative services).

Our result could then be interpreted as regards to the influence of institutions on contractual choices. We show that contractual choices are not only a matter of formal organizational structures. Informal rules, norms and social preferences also matter as they may attribute more or less value to equity concerns, and then lead to different contractual choices. These social norms and preferences may belong to the informal constraints described by North when defining what institutions are.[22] They can also be assimilated to social rules that structure social interactions, *i.e.* to institutions as defined by Hodgson [2006]. Then, our results suggest that those types of institutions are not neutral on contractual choices.

6 Conclusion

In this paper, we use an incomplete contract model to explore the consequences of the allocation of the demand risk in public-private partnerships. We show that allocating such a risk to the private operator (as under concession contracts) increases the incentives to innovate and to pay attention to the quality of the service (*i.e.* the economic performance of the service) but puts restriction on the access to the service. On the opposite, the demand risk is borne by public authorities in availability contracts, which allows a greater number

[21] As an example of cultural factor, there are some countries such as Germany for instance, where it is not admitted that car drivers have to pay a fee for the use of a highway. In Germany, the highway concessions are called A-modells, and the private operator can only charge trucks. Payment by car drivers is neither culturally nor politically accepted.

[22] "Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (...) and formal rules (...)", North [1991], p.97.

of users of the service, but decreases the incentives of the private operator to innovate taking into account quality considerations. In a nutshell, we show that there is no optimal contractual agremeent *per se* and that the decision should depend on :

- whether users are forced to use the service when they have no alternative options, *i.e.* if they are captive.
- the sensitivity of users to quality variations. Indeed, the role of users under concession allows to discipline the operator (to influence his incentives to invest) if the demand is elastic to the quality of the service.
- the sensitivity of the demand to the level of the fees.
- how contractible quality is. Indeed, in some sectors, quality can be very well defined, and potential innovations will not have intense adverse effects on quality, whereas in some other sectors, quality is hard to contract on, and there are a lot of potential efforts to make that can have an impact, be it positive or negative, on quality.
- whether social norms attribute more or less value to equity concerns, which may be linked to the institutional environment in which the contract is implemented.

This paper is a first step towards a better understanding of the allocation of demand risk in public-private partnerships. It also calls for many extensions. One could for instance introduce sustainable development considerations. In this case, innovations may not attract new users, but increase long-term social benefit. It then remains to find means to give private operators incentives to consider such innovations.
Our model also suggests that possible mixes of price structures may help to combine both objectives: for instance, one could imagine that the public authority pays for some quantities of service to deliver per inhabitant, and the quantity that the users would like above this level may be on their own charge. This could help to reconcile both equity considerations and performance requirements by making the revenue of the operator still dependant on his efforts to innovate (and attract users), while also ensuring that the basic consumption is delivered. Such hybrid allocation of the demand risk will deserve future research.

Appendixes

Appendix 1.

Thanks to the implicit function theorem and equations (5) and (6), we observe that the incentives i^C and e^C are increasing in the level of the fee:

$$\frac{d(i^C)}{df} = \frac{-[d^f]}{d^f\beta''(i^C)(f-\lambda)+\gamma v''(i^C)} \geq 0 \tag{9}$$

$$\frac{d(e^C)}{df} = \frac{-[d^f]}{c''(e^C)+d^f\phi b''(e^C)(f-\lambda)} \geq 0 \tag{10}$$

Appendix 2.

Concerning effort i, we remind from Section 3.4.2. that:

$$\begin{aligned} f\times d^f\beta(i) \leq \beta(i) &\Rightarrow f\times d^f \leq 1, \text{ and } \beta'(i)\geq 0 \\ &\Rightarrow f\times d^f\beta'(i) \leq \beta'(i) \\ &\Rightarrow (f-\lambda)\times d^f\beta'(i) \leq \beta'(i) \text{ for all } \lambda \geq 0 \\ &\Rightarrow (f-\lambda)\times d^f\beta'(i) \leq \bar{D}\beta'(i), \text{ since } \bar{D}\geq 1 \end{aligned}$$

This leads to conclude that: $\forall\gamma = \{-1;+1\}$, $i^C < i^{FB}$.

Concerning investment e, the ranking depends on the type of externality.
First, when $\phi = 1$

$$\begin{aligned} f\times d^f\phi b(e) \leq \phi b(e) &\Rightarrow f\times d^f \leq 1 \text{ and } \phi b'(e) > 0 \\ &\Rightarrow f\times d^f\phi b'(e) \leq \phi b'(e) \\ &\Rightarrow (f-\lambda)\times d^f\phi(b'(e)) \leq \phi b'(e) \text{ for all } \lambda\geq 0 \\ &\Rightarrow (f-\lambda)\times d^f\phi(b'(e)) \leq \bar{D}\phi(b'(e)) \end{aligned}$$

This indicates that when $\phi = +1$, $e^C < e^{FB}$.

Second, when $\phi = -1$

$$\begin{aligned} f\times d^f b(e) \leq b(e) &\Rightarrow f\times d^f \leq 1 \text{ and } b'(e) > 0 \\ &\Rightarrow f\times d^f b'(e) \leq b'(e) \\ &\Rightarrow (f-\lambda)\times d^f(b'(e)) \leq b'(e) \text{ for all } \lambda\geq 0 \\ &\Rightarrow (f-\lambda)\times d^f(b'(e)) \leq \bar{D}(b'(e)) \\ &\Rightarrow c'(e)-(f-\lambda)\times d^f(b'(e)) \geq c'(e)-\bar{D}(b'(e)) \end{aligned}$$

This indicates that when $\phi = -1$, $e^C \geq e^{FB}$.

References

Auriol, E. and P. M. Picard (2011). A theory of BOT concession contracts. *CEPR Discussion paper* (DP8323).

Barro, R. J. (1990, October). Government spending in a simple model of endogenous growth. *Journal of Political Economy 98*(5), S103–26.

Bennett, J. and E. Iossa (2006). Building and managing facilities for public services. *Journal of Public Economics 90*(10-11), 2143–2160.

CRE (2010). Rapport sur la "qualité de l'électricité". Diagnostics et propositions relatives à la continuité de l'alimentation en électricité, institution = Commission de Régulation de l'Energie. Technical report, Paris, FRANCE.

Delmon, J. (2010). Understanding Options for Public-private Partnerships in Infrastructure. *Policy Research Working Paper* (5173).

Demsetz, H. (1968). Why regulate utilities? *Journal of Law and Economics 11*(1), 55–65.

Engel, E., R. Fischer, and A. Galetovic (2011). The basic public finance of public-private partnerships. *forthcoming in the Journal of the European Economic Association* (257).

European Commission (2003). *Guidelines for Successful Public-Private Partnerships.*

European Commission (2004). *On public-private partnerships and community law on public contracts and concessions.* Brussels, Belgium: Commission of the European Communities.

Hart, O. (2003). Incomplete contracts and public ownership: Remarks, and an application to Public Private Partnerships. *Economic Journal 113*(485), C69–C76.

Hart, O., A. Shleifer, and R. W. Vishny (1997). The proper scope of government: Theory and an application to prisons. *Quarterly Journal of Economics 112*(4), 1127–1161.

Hodgson, G. (2006). What are institutions? *Journal of Economic Issues XL*(1), 1–25.

Hoppe, E., D. Kusterer, and P. Schmitz (2011). Public-private partnerships versus traditional public procurement: An empirical investigation. *Forthcoming in the Journal of Economic Behavior and Organization.*

Hoppe, E. and P. Schmitz (2010). Public versus private ownership: Quantity contracts and the allocation of investment task. *Journal of Public Economics.*

Laffont, J.-J. and D. Martimort (2002). *The theory of Incentives: The Principal-Agent Model.* Princeton and Oxford: Princeton University Press.

Laffont, J.-J. and J. Tirole (1993). *A Theory of Incentives in Procurement and Regulation.* Cambridge: MIT Press.

Martimort, D. and J. Pouyet (2008, March). "Build It or Not": Normative and Positive Theories of Public-Private Partnerships. *International Journal of Industrial Organization 26*(2), 393–411.

National Audit Office (2003). Operational performance of prisons. Technical report.

North, D. C. (1991, Winter). Institutions. *Journal of Economic Perspectives 5*(1), 97–112.

Tessier, A. (2004). Le livre vert de la commission europï¿½enne sur les partenariats public-privé et le droit communautaire des marchés publics et concessions. *Bulletin juridique des contrats publics 37*, 419–423.

Treasury, H. (2003). *PFI: Meeting the Investment Challenge.* London, UK: HM Treasury.

Williamson, O. E. (1999). Public and private bureaucracies: a transaction cost economics perspectives. *Journal of Law, Economics and Organization 15*(1), 306–342.

World Bank (2006). *Approaches to Private Participation in Water Services: A Toolkit.* Washington DC, USA: The World Bank and Public-Private Infrastructure Advisory Facility.