Counter-Incentives in Incomplete Contracts*

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Abstract

We consider an incomplete contract relationship between a public authority and a private manager (Public Private Partnership), where parties can hold-up each other. We compare availability and concession contracts, the two more frequently used contractual designs for delegating public services to private operators, which differ in terms of allocation of demand risk (demand risk being on the private provider in a concession contract and on the public authority in an availability contract). Contrary to common wisdom, we show that contracting parties' efforts are lower when they bear demand risk. We also determine the proper choice of contractual design and the model is applied to understanding two famous highway concession and school catering availability contract case studies.

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1 Introduction

In the last couple of decades, Public Private Partnerships (PPPs) have become worlwide increasingly popular in a broad range of public services (roads, bridges, schools, hospitals, prisons, etc.). However, many concerns have been raised regarding this organizational model (see Engel, Fischer, and Galetovic, 1997, Guasch, 2004, Chong, Huet, and Saussier, 2006, Estache, 2006, Martimort and Straub, 2006, Athias and Nunez, 2008, Guasch, Laffont, and Straub, 2008). The most stringent worries concern the ex post adaptation inflexibilities inherent to these long term contracts. It is often mentioned that "[a] key concern with long-term PPP contracts is the level of flexibility that they offer to authorities to make changes either to the use of assets or to the level and type of services offered" (PWHC 2005).

Public Private Partnerships encompass a variety of administrative arrangements (Grout and Stevens, 2003). Broadly speaking there are two main contract types for delegating public services to private operators: availability contracts where private providers bear no demand risk and concession contracts where private providers bear all demand risk. The resort to both types of contract is now possible in most countries. The traditional model of PPPs in the world has been the concession contract but countries around the world have recently promulgated guidelines so as to bring in the availability contract as an alternative to the concession contract, e.g. the June 2004 act in France instituting the new "contrats de partenariat".

This general background raises the question of the choice of the contractual design of PPPs; that is the question of when an availability contract has to be preferred to a concession contract and vice versa. In this paper, we compare the efficiency of availaibility and concession contracts in the lens of an incomplete contract perspective (Grossman and Hart, 1986, Hart and Moore, 1990, Hart, 1995, Hart, Shleifer and Vishny, 1997, Hart and Moore, 1999 and Hart, 2003). We consider a contractual relationship in which a public authority contracts with a private provider.[1] The private provider invests in non contractible cost reducing efforts, fully relationship specific. The public authority makes a non verifiable investment, which corresponds to an effort of adaptation of the public service provision over time so as to respect consumers changing demand. The adaptation of the public service can however only be implemented by the private provider. We show two original and counter-intuitive results. First, the public authority's investment in adaptation is lower when she bears demand risk. Second, we show that the private manager's cost reducing effort is lower when he bears demand risk. These results lead us to have predictions regarding the choice of the contractual design. We find that when the benefits from adaptation are important, it

[1] We will refer to the public authority as "she" and the private provider as "he".

is socially preferable to design a contract in which demand risk is on the private provider, whereas when the benefits from cost reducing efforts are important, it is socially preferable to put demand risk on the public authority.

These results are counter-intuitive compared to usual results of the moral hazard problem in the agency theory (Iossa and Martimort, 2008). Indeed, according to this theory, the agent will increase his effort when he bears more risk. By contrast, we consider an incomplete contract model in which both parties can hold up the other one. In such a model, when one party bears demand risk, it has less power to hold up the other contracting party, which gives more incentives to the latter to invest. These results are also original in two ways. First, incomplete contract studies have only focused on the public versus private tradeoff for the provision of public services, ignoring that the private provision of public services can take various forms. This paper is then to be considered as complementary to these previous studies. Second, incomplete contract studies have so far explained the ex post adaptation problems in PPPs by the distorted incentives for the private public-service provider to invest in the research into innovative approaches to carrying out the service provision (Hart, Shleifer and Vishny, 1997, Hart, 2003, and Bennett and Iossa, 2006). None of them give an active role to public authorities (except for Ellman 2006 and Athias 2009). By contrast, we assume that public authorities have an important role to play in the adaptation of the private provision of public services over time for the following reasons. First, any PPP is between a public authority and a private public-service provider; that is there is no direct democracy (the public cannot vote directly to select and oust the private provider). Second, there is no market accountability of private providers, since the price applied to consumers, if any, is a regulated price, not a market price. Finally, public authorities, as elected delegates of consumers, are duty bound to discover adaptations and consumers' preferences and to exercise pressure on the private provider to adapt the public service to satisfy the changes in the effective consumers demand. In other words, we have to consider public authorities as active players instead of passive bystanders of the general efficiency of PPPs. We apply then these original and counter-intuitive results to understanding two famous case studies, one reflecting the case of an availability contract (the British school catering case) while the other reflects the case of a concession contract (the highway concession case).

The paper is organized as follows. In Section 2, we present a simple model that leads to our theoretical propositions developed in Section 3. In Section 4, we apply the model to understanding two famous case studies and we provide our concluding remarks in the final Section 5.

2 The Model

There are two main contract types for delegating public services to private operators: contracts where private providers bear no demand risk (availability contracts),[2] and contracts where private providers bear all demand risk (concession contracts). Both are long-term, global contracts on the design, building, financing and operation of a public service and consist in output specifications systems. Both contracts can be considered as fixed-price contracts (the procuring authority offers the private provider a prespecified price for completing the project in both contracts). They do not differ in the magnitude of implication of the private operator, both contracting procedures formally delegate to the private provider sufficient residual control rights to provide the service free of interference. The main difference between these two contractual practices concerns the allocation of demand risk. Thus, under a concession contract, the private provider's remuneration depends on the demand for the public service whereas under an availability contract, it comes from service payments by the procuring authority according to performance criteria (the contract specifies penalties in case the performance and quality criteria are not met); there is therefore no link with the service demand. The following section presents a simple incomplete contract model of contractual design for the provision of a public service by a private provider.

2.1 Model Framework

We consider a contractual relationship in which a public authority PA contracts with a private provider PM, which generates a profit Π and a consumer suprlus CS. The private provider invests e in cost reducing efforts, which generates for him a cost advantage of $w(e)$ (increasing and concave).[3] The investment e is not contractible and nor $w(e)$. We assume that this cost reduction investment is fully relationship specific, i.e. PM does not get any benefit from e outside the relationship.

The public authority makes a non verifiable investment j, which corresponds to an effort of adaptation of the public service provision over time so as to respect consumers changing

[2] Iossa and Martimort (2008) distinguish three types of PPP contract, depending on whether the payment is based on (i) user charges, (ii) usage, or on (iii) availability. In the first case, the private provider bears all demand risk. In the second case, the allocation of demand risk depends on the relationship between the payment and the actual usage level. In the third case, the public authority retains all demand risk. It is in fact contractually possible to restrict the demand risk imposed on the private provider within a concession contract (Athias and Saussier 2007), so that public authorities do not face a binary choice of contracts but a continuum choice. However, this does not question the results we obtained to the extent that the weaker the extent to which the private provider bears the demand risk, the weaker his probability of bankruptcy, everything else being equal.

[3] Since in both contractual designs, PM has control rights over the service provision, e will be implemented unilaterally.

demand. Both profit and consumer surplus are increasing functions of j.

As already highlighted, a critical aspect of any PPP is the allocation of demand risk between the public authority and the private provider. The means through which demand risk is allocated is the payment mechanism, either based on the demand level or on availability. In a mechanism based on availability, the public authority rewards the private provider for making the public service available but the payment is independent of the demand for the service. In such a case, the public authority retains all demand risk and receives the profit from the service. In a payment mechanism based on the demand level, it is the private provider that receives the profit. Note that if the public authority can receive the profit as the private provider, contrary to the private provider her objective function also includes the consumer surplus.

We assume that when the private provider bears demand risk, he can experience negative profits leading to the concession failure and the exit of the private provider (in other words, he goes bankrupt).[4] This is never the case for the public authority. We also assume that the private provider cannot be replaced by a new one except when he goes bankrupt (except if the public authority breaks the contract, which is prohibitively expensive). This assumption relies on the fact that the adaptation is extracontractual and the private provider cannot be legally sanctioned for not implementing the adaptation. We consider then that when the demand risk is on the private provider and the adaptation innovation is not implemented, the private provider can go brankrupt with a probability $1 - \rho$. This probability could be assumed to be a function of the cost reduction effort of the agent, i.e. $\rho \equiv \rho(e)$, as a cost reduction logically decreases the probability of bankruptcy. However, for the ease of exposition, we will assume that this probability does not depend on the private provider cost reduction effort (in appendix B, we relax this assumption and we show that our qualitative results are not affected).

We make usual assumptions on the functions Π, CS, and w: $\Pi(0) = \Pi_0 < +\infty$, $CS(0) = CS_0 < +\infty$, $\Pi' + CS' > 0$, $\Pi'' + CS'' < 0$, $\underset{j \to 0}{lim} (\Pi' + CS') > 1$, $\underset{j \to +\infty}{lim} (\Pi' + CS') < 1$; $w' > 0$, $w'' < 0$, $w(0) = 0$, $\underset{e \to 0}{lim} w'(e) = +\infty$ and $\underset{e \to +\infty}{lim} w'(e) = 0$.

The timing of the model is as follows:

Stage 0: The demand risk is either on PA or on PM.

Stage 1: PA and PM sink their respective investments j and e.

Stage 2: Renegotiation takes place to allow the adaptation to be implemented in the service provision: PA and PM share the surplus generated by j à la Nash bargaining.

[4] The profitability of most concession contracts is in fact very sensitive to the demand, i.e. a marginal change of the demand is enough to generate negative profits for the private provider. Guash (2004) reports for instance that around 6% of the toll road concessions granted in 1990-2001 worldwide were abandoned.

Stage 3: PA and PM trade (jointly or with their market alternatives).

In this paper, we voluntarily neglect the private provider's potential role in discovering adaptation. It is not to deny its importance (Hart, Shleifer and Vishny, 1997, Besley and Ghatak, 2001, Hart, 2003, and Bennet and Iossa, 2006), but if we assume that the benefits are separable in the public authority and the private provider adaptation investments, the private provider adaptation investment equilibrium level does not vary according to the contractual design.

2.1.1 Default payoffs

When the private provider bears demand risk, he can go bankrupt (with probability $1-\rho$) if the innovation j is not implemented. We assume this is the only situation where the public authority can replace the private provider with a new one. Moreover, if this scenario happens, the public authority will implement an incentive contract such that the new private provider will implement the innovation and she obtains all the surplus, $CS(j)+\Pi(j)$. If the innovation is not implemented and the private provider does not go bankcrupt (with probability ρ), the public authority payoff is the consumer surplus level associated with the basic service, $CS_0 > 0$. The expected default payoff of the public authority is then $(1-\rho)(CS(j)+\Pi(j))+\rho CS_0$ when the private provider bears demand risk

The default payoff of the private provider is 0 if the innovation is not implemented and he goes bankrupt (with probability $1-\rho$) and if he does not go bankrupt, his default payoff is (with probability ρ) the profit from the service with no innovation implemented, $\Pi_0+w(e)$. The expected default payoff of the private provider is then $\rho(\Pi_0+w(e))$ when he bears demand risk.

When the public authority bears demand risk, the private provider cannot go bankrupt and then the public authority cannot replace the private provider. The contract is for availability of the basic service and the public authority pays a fixed payment t_0 to the private provider. The default payoff of the private provider is $t_0+w(e)$ and the default payoff of the public authority is $CS_0+\Pi_0-t_0$, that is the level of welfare when no innovation is implemented.

2.1.2 First best

The first best solution is the couple of investment (j^*,e^*) that maximizes the total surplus, that is the sum of consumers surplus, profits and the cost advantage net of the cost of the investments:

$$(j^*,e^*)=\arg\max_{(j,e)}\{CS(j)+\Pi(j)+w(e)-j-e-(CS_0+\Pi_0)\} \tag{1}$$

The unique solution (j^*, e^*) is such that:

$$\begin{aligned} CS'(j^*) + \Pi'(j^*) &= 1 & (2) \\ w'(e^*) &= 1 & (3) \end{aligned}$$

At the social optimum, the marginal benefits of the investments must equal their marginal costs, that is 1 in both cases.

2.1.3 Equilibrium when the private provider bears demand risk

Suppose that the private provider bears demand risk. Renegotiation takes place and generates a surplus $CS(j) + \Pi(j) + w(e)$ that is splitted equally. The gain from renegotiation for each side is

$$\begin{aligned} & \frac{1}{2}\left[CS(j) + \Pi(j) + w(e) - (1-\rho)(CS(j) + \Pi(j)) - \rho(CS_0 + \Pi_0 + w(e))\right] \quad (4) \\ = \; & \frac{\rho}{2}\left[CS(j) + \Pi(j) - (CS_0 + \Pi_0)\right] + \frac{1-\rho}{2} w(e) \end{aligned}$$

The payoff of each agent is the sum of his/her default payoff and his/her gain from renegotiation net of the cost of his/her individual investment. Formally, PM's payoff is given by:

$$\begin{aligned} & U_{PM} = \rho(\Pi_0 + w(e)) + \frac{\rho}{2}\left[CS(j) + \Pi(j) - (CS_0 + \Pi_0)\right] + \frac{1-\rho}{2} w(e) - e \quad (5) \\ = \; & \frac{\rho}{2}(CS(j) + \Pi(j) - CS_0 + \Pi_0) + \frac{1+\rho}{2} w(e) - e \end{aligned}$$

and, PA's payoff is:

$$\begin{aligned} U_{PA} &= (1-\rho)(CS(j) + \Pi(j)) + \rho CS_0 + \frac{\rho}{2}\left[CS(j) + \Pi(j) - (CS_0 + \Pi_0)\right] + \frac{1-\rho}{2} w(e) - j \\ &= \left(1 - \frac{\rho}{2}\right)(CS(j) + \Pi(j)) + \frac{\rho}{2}(CS_0 - \Pi_0) + \frac{1-\rho}{2} w(e) - j \quad (6) \end{aligned}$$

Remark that when the bankruptcy risk is null, that is $\rho = 1$, the parties split the gain from adaptation equally (there is no gain from cost saving). PM chooses e that maximizes his payoff, U_{PM} and PA chooses j that maximizes her utility U_{PA}. The solution is denoted (e_{CC}, j_{CC}) and solves:

$$\underset{e}{Max}\left\{U_{PM} = \frac{\rho}{2}(CS(j) + \Pi(j) - CS_0 + \Pi_0) + \frac{1+\rho}{2} w(e) - e\right\} \quad (7)$$

and,

$$\underset{j}{Max}\left\{U_{PA}=\left(1-\frac{\rho}{2}\right)\left(CS\left(j\right)+\Pi\left(j\right)\right)+\frac{\rho}{2}\left(CS_{0}-\Pi_{0}\right)+\frac{1-\rho}{2}w\left(e\right)-j\right\} \tag{8}$$

The couple of investments (e_{CC}, j_{CC}) is characterized by the two following first order conditions:

$$\frac{1+\rho}{2}w'\left(e_{CC}\right)=1 \tag{9}$$

and,

$$\left(1-\frac{\rho}{2}\right)\left(CS'\left(j_{CC}\right)+\Pi'\left(j_{CC}\right)\right)=1 \tag{10}$$

Both investments deviate from the first best. First, as PM may go to brankrupt, he gets full return of his cost reduction investment only with probability $\frac{1+\rho}{2}$. Second, PA does not get the full return of her investment in adaptation, because she needs the agreement of PM to implement the innovation. However the hold up of the private provider is weakened as he can go bankrupt if he refuses to implement PA's innovation. The social surplus in the case where PM bears demand risk is defined as

$$W_{CC}=CS\left(j_{CC}\right)+\Pi\left(j_{CC}\right)+w\left(e_{CC}\right)-j_{CC}-e_{CC} \tag{11}$$

2.1.4 Equilibrium when the public authority bears demand risk

Suppose that the public authority bears demand risk. Renegotiation takes place and generates a surplus $CS\left(j\right)+\Pi\left(j\right)+w\left(e\right)$ that is splitted equally. The gain from renegotiation for each side is $\frac{1}{2}\left(CS\left(j\right)+\Pi\left(j\right)-\left(CS_{0}+\Pi_{0}\right)\right)$. We can now write the payoffs of the two agents.

PM's payoff is:

$$U_{PM}=t_{0}+w\left(e\right)+\frac{1}{2}\left(CS\left(j\right)+\Pi\left(j\right)-\left(CS_{0}+\Pi_{0}\right)\right)-e \tag{12}$$

and, PA's payoff is:

$$\begin{aligned} U_{PA} &= CS_{0}+\Pi_{0}+\frac{1}{2}\left(CS\left(j\right)+\Pi\left(j\right)-\left(CS_{0}+\Pi_{0}\right)\right)-j-t_{0} \\ &= \frac{1}{2}\left(CS\left(j\right)+\Pi\left(j\right)+CS_{0}+\Pi_{0}\right)-j-t_{0} \end{aligned} \tag{13}$$

Notice that, as the public authority and the private provider (when the public authority bears demand risk) cannot go bankrupt, then parameter ρ plays no role here. PM chooses e that maximizes his payoff, U_{PM} and PA chooses j that maximizes her utility U_{PA}. The solution is denoted (e_{AC}, j_{AC}) and solves:

$$\underset{e}{Max}\left\{U_{PM} = t_0 + w(e) + \frac{1}{2}\left(CS(j) + \Pi(j) - (CS_0 + \Pi_0)\right) - e\right\} \tag{14}$$

and,

$$\underset{j}{Max}\left\{U_{PA} = \frac{1}{2}\left(CS(j) + \Pi(j) + CS_0 + \Pi_0\right) - j - t_0\right\}. \tag{15}$$

The couple of investments (e_{AC}, j_{AC}) is characterized by the two following first order conditions:

$$w'(e_{AC}) = 1 \tag{16}$$

and,

$$\frac{1}{2}\left(CS'(j_{AC}) + \Pi'(j_{AC})\right) = 1 \tag{17}$$

Contrary to the case where PM bears demand risk, here PM gets all the return from his cost reduction investment because he cannot go bankrupt. However, PA cannot replace the private provider and still needs his agreement to implement the innovation. The social surplus in the case where PA bears demand risk is defined as

$$W_{AC} = CS(j_{AC}) + \Pi(j_{AC}) + w(e_{AC}) - j_{AC} - e_{AC} \tag{18}$$

2.1.5 The choice of the contractual design

The optimal contractual design is the one that generates the highest total surplus. It is socially desirable that PM rather than PA bears demand risk only if

$$W_{CC} \geq W_{AC} \tag{19}$$

or,

$$CS(j_{CC}) + \Pi(j_{CC}) + w(e_{CC}) - j_{CC} - e_{CC} \geq CS(j_{AC}) + \Pi(j_{AC}) + w(e_{AC}) - j_{AC} - e_{AC} \tag{20}$$

The determination of the socially preferred demand risk allocation requires a comparison between the investments levels under both contractual designs.

3 Analysis of investments and the choice of the contractual design

When the contract is designed such that the public authority bears demand risk (availability contract), this creates one distortion compared to the first best case. The public authority places $\frac{1}{2}$ weight on the benefit of adaptation (see equation (15)) instead of 1 in the first best case (see equation (1)). Regarding the cost reduction effort of the private provider, there is no distortion (conditions (16) and (3) are identical). The following result follows directly from the first order conditions and our assumptions on the properties of the functions $CS+\Pi$.

Proposition 1: *When the public authority bears demand risk, investments in adaptation are sub-optimal, $j_{AC} < j^*$, but investments in cost reduction are optimal, $e_{AC} = e^*$.*

Remark that the probability of bankrupt ρ plays no role in this result. This is because the private provider can only go bankrupt when he bears demand risk. The deviation from the first best is only due to the renegotiation as in the seminal work of Hart et al. (1997). Hold-up reduces the incentives to make an appropriate adaptation effort. However, in our model, the adaptation effort is made by the public authority and this is of importance for the next result.

Regarding now the second contractual design, where the private provider bears demand risk (concession contract), the possibility that the private provider goes bankrupt when he does not implement the adaptation asked by the public authority induces two distortions compared to the availability contract. First, the public authority places $\left(1 - \frac{\rho}{2}\right)$ weight on the benefit of adaptation (see equation (8)) instead of $\frac{1}{2}$ in the case of an availability contract (see equation (15)). When the probability of bankruptcy is positive ($\rho < 1$) the former is larger than the latter. Nevertheless, this weight is still lower than in the first best situation. Second, the private provider places $\frac{1+\rho}{2}$ (≤ 1) weight on the cost reduction gain (see equation (7)) instead of 1 in the availability contract or the first best situation (see equations (14) and (1)). The following result follows directly from the corresponding first order conditions and our assumptions on the functions $CS + \Pi$ and w.

Proposition 2: *Public authority's investment in adaptation is lower when she bears demand risk, $j_{AC} \leq j_{CC} \leq j^*$, and private manager's cost reducing effort is lower when he bears demand risk, $e_{CC} \leq e_{AC} = e^*$. (with $j_{AC} < j_{CC}$ and $e_{CC} < e_{AC}$ unless $\rho = 1$ and $j_{CC} < j^*$ unless $\rho = 0$).*

Contrary to the availability contract, the concession contract put the private provider to face the risk of bankruptcy in case of renegotiation failure. The public authority holds up then a larger share of the cost reduction efforts benefit, which counter-incites the private provider to invest in cost reducing efforts.. The private provider hold-ups in turn a smaller share of the adaptation benefits, which provides an incentive to the public authority to increase her adaptation effort. In other words, the bankruptcy risk gives more power to the public authority at the renegotiation stage, which increases her incentives to make adaptation efforts but reduces the private provider incentives to make cost reduction efforts. These results enable us to provide some predictions regarding the choice of the contractual design:

Proposition 3:

(1) Suppose that the function $CS(j) + \Pi(j)$ *is replaced by* $\tau(CS(j) + \Pi(j))$*, then for* τ *sufficiently small, it is preferable that the public authority rather than the private provider bears demand risk.*

(2) Suppose that the function $w(e)$ *is replaced by* $\sigma w(e)$*, then for* σ *sufficiently small, it is preferable that the private provider rather than the public authority bears demand risk.*

(The proof is reported in Appendix A).

Part (1) assumes that τ becomes close to zero. The adaptation efforts j_{CC}, j_{AC} and j^* becomes all close to zero and then only the value of the cost reduction effort matters. As the availability contract is socially preferable over this dimension, it is also preferable for τ sufficiently small. Part (2) is a symmetric result. It assumes that σ becomes close to zero, and then the cost reduction efforts e_{CC}, e_{AC} and e^* becomes all close to zero and then only the value of the adaptation effort matters. As the concession contract is socially preferable from the point of view of adaptation, it is also preferable for σ sufficiently small.

This proposition highlights first the fact that no contractual design is optimal and second that no contractual design always dominates the other one. In other words, the contract in which demand risk is on the private provider always dominates the contract in which demand risk is on the public authority regarding the incentives of the PA to invest efforts to adapt the service provision to consumers changing demand. Nevertheless, the contract in which demand risk is on the PA always dominates the contract in which demand risk is on the private provider regarding the private provider's cost-cutting incentives. A tradeoff occurs therefore between putting demand risk on the private provider to raise public authority's adaptation investments, and and not putting demand risk on the private provider to raise his cost-reducing efforts.

We conclude that when the benefits from adaptation are important, it is socially preferable to design a contract in which demand risk is on the private provider, whereas when the benefits from cost reducing efforts are important, it is socially preferable to put demand risk on the public authority.

4 Case studies

This section illustrates the underlying logic of the model in the context of two case studies. One case study illustrates the case of an availability contract (the school catering case) while the other one reflects the case of a concession contract.

4.1 The School Catering Case

The experience of the British government with school dinners offers a good example of the incentives provided by an availability contract, i.e. a contract in which the private provider does not bear demand risk. According to Ellman (2006), "In the aftermath of a series of television reports on school diners by celebrity chef Jamie Oliver in early 2005, the government rushed to quench mounting public discontent over low quality committing to make improvements. However, new schools locked into 25-year contracts through private finance initiatives (PFIs) are finding that they cannot rid their menus of junk food despite the government's pledge". Notice that PFI contracts are typical availability contracts. In this case, we can observe that the private provider, who does not bear demand risk, invested in cost reducing efforts whereas the procuring authority had very low power to make the private provider adapt the service according to the fundamental change in the consideration of healthy food by the public. This perfectly illustrates Proposition 2 of our model, which states that there is weak adaptation under an availability contract whereas the cost reducing efforts of the private provider are high.

If we now consider the features of this case in light of our theoretical model, the socially preferable contractual design would be to make the private provider bear demand risk. As a matter of fact, we can consider that the social gain to have a school catering of good quality is very high. The main argument relies on public health considerations as junk food is now considered as a main cause of health disease. Another argument is the potential high cost of not having a school catering in terms of opportunity costs for parents to have their children for lunch everyday as well as in terms of security if they let them get a lunch by themselves. If we follow Proposition 3 (1), this means that the value of τ is high, and that it is preferable that the private provider, rather than the public authority, bears demand risk. If such a choice would have been made, our model predicts that adaptation would have been more likely implemented. However, it is important to note that in the case of universities, we can speculate that putting demand on the private provider would be less likely socially preferable. This is due to the fact that the considerations of healthy consequences of junk food on the growing of students would be less important, the security matter would also be reduced as well as the opportunity costs for parents.

This case well illustrates the consequences of an availibility contract on incentives. However, as it is a failure, our predictions regarding the socially preferable contract remain speculative. In the following subsection, we will consider a success story that will allow us to compare our theoretical predictions with the observed contractual choice.

4.2 The Highway Case: The Episode of the "Shipwrecked Men of the Road"

In France, the provision of highways is made through concession contracts. On January 4, 2003, the French Weather-Forecaster underestimated the extent of the falls of snow which will fall down on the French North and Centre. As a consequence, the concerned private provider did not take all the necessary measures to preserve the viability of the base joint of two highways. Thus, when plates of glaze appeared on this base joint, already dense circulation became completely blocked. The absence of measures such as the diversion of traffic and information of the users by the private provider increased the number of users blocked out of 60 km. After this event, there was a public discontent about the lack of suitable means in case of considerable falls of snow. As a consequence, as required by the French government, the private provider invested in less heavy salting vehicles as well as in automatic salting systems located in crucial points.

Thus, in contrast with the former one, this case study highlights the fact that under a concession contract, in case of changing public demand or problems, service adaptation can occur. This is in line with Proposition 2 ($j_{CC} > j_{AC}$). This case also highlights the fact that when potential benefits in non contractible cost reducing efforts are weak, which is the case for highways that are standard infrastructure, the socially preferable contract design is to put demand risk on the private provider (in line with Proposition 3.(2) with a low σ).

Note that in both previous case studies, either benefits from adaptation are important or benefits from cost-reducing efforts are weak, so that it is in both situations socially preferable to design a contract in which demand risk is on the private provider. Again, this does not imply that the model of the concession contract is always optimal, as speculated in the case of universities catering.

5 Conclusion

In this paper, we have studied the effects of the demand risk allocation on the incentives of the PPP contracting parties. We have focused on the adaptation investments of the public authority and voluntarily neglected the adaptation efforts of the private provider. While we have mentioned that considering adaptation efforts from both parties does not affect our results if adaptation benefits are separable, an interesting extension might be to consider their interactions (whether they are complementary or substitutable). This could lead to interesting insights but introduce complex effects in the analysis.

Our model is very simple but we think it captures the most important tradeoffs at stake in the efficiency of PPPs. We first show that the incentives of the contracting parties are weakened when they bear demand risk. This is a new case of counter-incentives. Few papers have put in evidence this kind of phenomenon but with very different mechanisms (e.g. Benabou and Tirole, 2006, with the crowding out effects of monetary incentives, Lazear (1989) with sabotage in promotion tournaments). We also show that the demand risk allocation will vary according to the relative importance of the benefits from adaptation compared to the benefits from cost reducing efforts, highlighting that no contractual design is optimal and always dominant. This result questions the current common belief that to not impose demand risk on private providers is a good solution to the problems encountered with concession contracts. In addition, this paper suggests that the current trend towards the increasing adoption of availability contracts should not lead to the abolition of the concession contract model but that the two contract types should coexist.

Appendix A

Proof of Proposition 3: To show (1), replace $CS(j) + \Pi(j)$ by $\tau(CS(j) + \Pi(j))$. Conditions (10) and (17) become:

$$\left(1 - \frac{\rho}{2}\right)\left(CS'(j_{CC}) + \Pi'(j_{CC})\right) = \frac{1}{\tau}, \tag{21}$$

and,

$$\frac{1}{2}\left(CS'(j_{AC}) + \Pi'(j_{AC})\right) = \frac{1}{\tau}. \tag{22}$$

Since $CS'' + \Pi'' < 0$ and $\underset{j \to 0}{lim}(\Pi' + CS') = +\infty$, when τ goes to 0, both j_{CC} and j_{AC} also go to 0. Thus, the social surplus in the case where PM bears demand risk becomes:

$$\underset{\tau \to 0}{lim} W_{CC} = w(e_{CC}) - e_{CC}, \tag{23}$$

and the social surplus in the case where PA bears demand risk becomes:

$$\underset{\tau \to 0}{lim} W_{AC} = w(e_{AC}) - e_{AC} \tag{24}$$

According to Proposition 1, we have $e_{AC} = e^*$ where e^* maximizes $e \mapsto w(e) - e$. Using Proposition 2, we know that $e_{CC} \leq e_{AC}$ (with $e_{CC} < e_{AC}$ unless $\rho = 1$) and then,

$$\underset{\tau \to 0}{lim}\, W_{CC} \leq \underset{\tau \to 0}{lim}\, W_{AC}, \tag{25}$$

with $\underset{\tau \to 0}{lim}\, W_{CC} < \underset{\tau \to 0}{lim}\, W_{AC}$ unless $\rho = 1$.

To show (2), replace $w(e)$ by $\sigma w(e)$. Conditions (9) and (16) become:

$$\frac{1+\rho}{2} w'(e_{CC}) = \frac{1}{\sigma}, \tag{26}$$

and,

$$w'(e_{AC}) = \frac{1}{\sigma}. \tag{27}$$

Since $w'' < 0$ and $\underset{e \to +\infty}{lim}\, w'(e) = 0$, when σ goes to 0, both e_{CC} and e_{AC} also go to 0. Thus, the social surplus in the case where PM bears demand risk becomes:

$$\underset{\tau \to 0}{lim}\, W_{CC} = CS(j_{CC}) + \Pi(j_{CC}) - j_{CC}, \tag{28}$$

and the social surplus in the case where PA bears demand risk becomes:

$$\underset{\tau \to 0}{lim}\, W_{AC} = CS(j_{AC}) + \Pi(j_{AC}) - j_{AC}. \tag{29}$$

According to Proposition 2, the investment in adaptation is closer to the (unique) optimal value for a concession contract compared to an availaibility contract, $j_{AC} \leq j_{CC} \leq j^*$ (with $j_{AC} < j_{CC}$ unless $\rho = 1$) and then $\underset{\tau \to 0}{lim} W_{AC} \leq \underset{\tau \to 0}{lim}\, W_{CC}$ (with $\underset{\tau \to 0}{lim} W_{AC} < \underset{\tau \to 0}{lim}\, W_{CC}$ unless $\rho = 1$).

Appendix B: cost reducing effort and probability of bankruptcy

In the body of the paper, we have assumed that the probability of bankruptcy was independent of the cost reducing effort of the private provider. This simplifying assumption is not natural and then deserves some further justification. In this appendix, we relax this assumption and show it is not crucial to our results.

We have to adapt the model for the case where the private provider bears demand risk. The first step is to link the PM profit with the probability of bankruptcy.

Assume that the demand for the service D is D_0 when an innovation with a low value j is implemented (e.g., a low "quality" innovation), $j < j_0$, and it is an increassing function of j, $Q(j)$, when an innovation with a high value is implemented, $j \geq j_0$. Formally,

$$D(j) = \begin{cases} Q(j) \text{ if an innovation } j \geq j_0 \text{ is implemented} \\ Q_0, \text{ else} \end{cases}.$$

The PM profit is given by

$$\Pi(j) = pD(j) - F,$$

where F represents the production costs. Assume that the profit $\Pi_0 (= \Pi(0))$ is not perfectly known and is drawn from a **cumulative distribution function G.** When the private provider bears deand risk and the innovation j is not implemented, the profit of the private provider is $\Pi_0 + w(e) - e$. The probability of bankruptcy is then defined as $1 - \rho = \Pr(\Pi_0 < -w(e) + e) = G(-w(e) + e)$. In other words, ρ is an increasing function of $w(e) - e$. Let $\rho \equiv \rho(w(e) - e)$.

The expected default payoff of the public authority is still $(1-\rho)(CS(j) + \Pi(j)) + \rho CS_0$. Let $\pi(w(e) - e) = E[\Pi_0 / \Pi_0 > -w(e) + e]$ and notice it is an increasing function. The expected default payoff of the private provier (for $w(e) \geq e$) is now

$$\int_{-w(e)+e}^{+\infty} (\Pi_0 + w(e))\, dG(\Pi_0) = (1 - G(-w(e) + e))(\pi(w(e) - e) + w(e)) \tag{30}$$

$$= \rho(e)(\pi(w(e) - e) + w(e)). \tag{31}$$

The gain from renegotiation for each side is now

$$\frac{1}{2}[CS(j) + \Pi(j) + w - (1-\rho)(CS(j) + \Pi(j)) - \rho CS_0 - \rho(\pi + w)] \tag{32}$$

$$= \frac{\rho}{2}[CS(j) + \Pi(j) - (CS_0 + \pi)] + \frac{1-\rho}{2} w.$$

PM's payoff is then given by:

$$U_{PM} = \frac{\rho}{2}(CS(j) + \Pi(j) - CS_0 + \pi) + \frac{1+\rho}{2} w - e \tag{33}$$

and PA's payoff is given by:

$$U_{PA} = \left(1 - \frac{\rho}{2}\right)(CS(j) + \Pi(j)) + \frac{\rho}{2}(CS_0 - \pi) + \frac{1-\rho}{2} w - j. \tag{34}$$

These expressions differ with those derived in the body of the paper because ρ and π depend on $w(e) - e$. This implies a potential difficulty as we cannot claim that U_{PM} is always quasi-concave.

The equilibrium in the case where the public authority bears demand risk is unchanged. **Assuming (for the sake of simplicity) that** $j_0 \leq j_{AC}$, the couple of investments (e_{AC}, j_{AC}) is still characterized by the two following first order conditions:

$$w'(e_{AC}) = 1 \tag{35}$$

and,

$$\frac{1}{2}\left(CS'(j_{AC}) + \Pi'(j_{AC})\right) = 1 \tag{36}$$

The derivative of U_{PM} defined in equation (33) with respect to e is:

$$\frac{\partial U_{PM}}{\partial e} = \frac{\rho'}{2}\left[CS(j) + \Pi(j) - CS_0 + \pi\right][w' - 1] + \frac{\rho}{2}[w' - 1]\pi' + \frac{\rho'}{2}[w' - 1]w + \frac{1+\rho}{2}w' - 1$$

For any $e \geq e_{AC}$ we have $w'(e) - 1 \leq 0$ because $w(e) - e$ is concave and maximized at point $e = e_{AC}$. Since $\rho \leq 1$, U_{PM} is decreasing for any $e \geq e_{AC}$. We conclude that $e_{CC} < e_{AC}$.

The derivative of U_{PA} defined in equation (34) with respect to j is:

$$\frac{\partial U_{PA}}{\partial e} = \left(1 - \frac{\rho}{2}\right)\left(CS'(j) + \Pi'(j)\right) - 1.$$

Since U_{PA} is still concave in j and $\rho \leq 1$, the ranking of the innovation efforts is not affected, we still have $j_{AC} \leq j_{CC}$.

In the body of the paper, we have highligthed the counter incentive (induced by the hold-up problem) that pushes the private provider to reduce his effort when he bears demand risk. In this appendix, we have (re) introduced a more standard effect, considering that the private provider has incentives to invest in cost-reducing efforts in order to reduce the risk of bankruptcy. However, as long as the probability of bankruptcy exists, the private provider has still less incentives to make cost reducing efforts under the concession contract than under the availability contract.

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