Putting all one's eggs in one Basket: Relational contracts and the provision of local public services

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Abstract

The contracting out of local public services has kept on increasing over the past decades. We observe that local governments regularly choose the same private operator for their different services, i.e. they "bundle" and delegate them to a single firm. We develop a model of relational contracts that shows how this strategy may lead to better performance at lower cost for the public authority. Such a proposition is tested and corroborated using an original database concerning the contractual choices made by 5000 French local public authorities in 1998, 2001 and 2004.

1 Introduction

The role of the private sector in the management of public services has raised many questions in the last decades, especially at the local government level. In many countries, local public authorities such as municipalities have to provide a wide range of services (street repair, water management, sewage, urban transport, ...). Recent stylized facts show an increasing involvement of the private sector. For instance, in the U.S., around one third of residential solid waste collection, of solid waste disposal or of street repair are provided through contracts with private firms (Levin and Tadelis [2008]). In Europe, such a contracting out has even more success: to quote the case of French medium-size cities, 63% of them contract out water production and distribution, and 58% delegate sewage (Dexia Crédit Local de France [2006]).

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While theoretical debates about the management of local public services first focused on the determinants of privatization, the topics of concerns have then been enlarged. For instance, the selection mechanisms (competitive bidding *versus* negotiations) have been compared to determine their respective efficiency (Bajari et al. [2009]). However, what determines the choice of private operators in practice has drawn less attention. When observing the choice of local public authorities that contract out their services, it is surprising to see that many of them “bundle" their services, i.e. they concentrate the various services they have in charge in the hands of a single operator.[1] Therefore, in many countries, it seems that public authorities have been rather convinced to contract out local public services, but in parallel concentrate them in the hands of one single partner, even if they have the means to choose between several candidates. In this paper, we focus on the reasons why public authorities may deliberately choose to bundle their services and to attribute them to the same operator. We show that it may be a means to achieve a better efficiency at lower cost, by contributing to the self-enforcement of informal contracts.

The perspective we adopt here takes contractual incompleteness for granted: Indeed, the quality of services the public authorities want is often difficult or prohibitively costly to specify in details ex ante, at least in a way to be enforced by courts (Hart et al. [1997]). As a consequence, renegotiations occur ex post. Yet, following the notion of "relational contracts as defined by Baker et al. [2002] or Baker et al. [2008], parties may also tacitly agree on the way uncontractible parameters can be managed. As those informal dealings cannot be enforced by courts, their self-enforcement comes from the perspective of future business between partners, and the need for a good reputation. Goldberg [1976], or recent reports such as that of the European Commission [2004b] underline how such informal relationships between public and private contractors may help to circumvent difficulties in formal contracting.[2]

To explain the strategy of bundling through relational contracting, we start by developing a model where a public authority decides to contract out the management of two services, whose uncontractible investments have different impacts on social benefit. The public authority can decide either to bundle her services to one single private operator, or she can choose two different managers. The key question in our paper is whether such a choice has consequences on promises about how to deal with non-contractible outcomes. We show that in a static framework, these informal dealings prove to be irrelevant, and whether transactions are bundled or not has no impact. Nevertheless, when parties have concerns for future business, relational contracts can encourage optimal actions. We demonstrate that a private partner may accept to invest at a level that is socially optimal, if he is rewarded for such a behavior, by a bonus or a promise to be chosen again in subsequent periods. His deviation can be punished in the long run. We found that with two different services, one with and the other without adverse effects of cost reduction on social benefits, informal agreements are more easily sustainable when the private manager has both contracts in charge. The bonus the public authority has to pay to achieve the social optimum is then lower, which means that the total price paid to manage both services is also lower when services are bundled. Our main result is thus to show that, under some conditions, the bundling of services forces the private manager to respect the informal dealing at lower costs. In other words, this strategy implies for a public authority to put all her eggs in one basket, which appears as an instrument in the service of the parties' relationship.

We then test such a proposition on an original panel database combining data from the French Environment Institute (IFEN) and the French Health Ministry (DGS), concerning 5000 local public authorities and their contractual choices in force in 1998, 2001 and 2004. The French case is here particularly interesting, since municipalities have the legal obligation to provide some services, but are free to choose how to provide them. Many municipalities choose the contracting-out of services (Dexia Crédit Local de France [2006]).[3] In this case, a competition is organized among several firms willing to enter the market for a given period of time at the end of which, the market is reopened for competition. Such a principle aims to achieve a greater efficiency (Demsetz [1968]) and has been promoted by the legislator, both at national and European levels.[4] The mechanism of selection of the private operator includes some negotiations, with room for informal dealings.[5] Our results show that the choice of the same operator in order to operate both distribution and sanitation of water is not random and is not neutral. More precisely, this strategy leads to a significant price reduction corroborating our main proposition.

We believe our paper is a contribution to the literature on relational contracting and on public-private partnerships. Our modeling approach is inspired by previous works on relational contracts elaborated by Baker et al. [1994, 2002, 2008]. More specifically, Baker et al. [1994] show how both objective and subjective performance measures allow to achieve optimal incentive mechanisms. In our paper, the combined use of formal and informal tools also helps to circumvent difficulties in contracting. However, our contribution departs from their approach that considers the perspective of future transactions as the main enforcer of informal dealings. On the contrary, we show that the number of transactions between identical partners also participates to the enforcement of informal contracts. Furthermore, we provide, as far as we know, the first econometrical test of this proposition on a public private contracts database.

More broadly, organizational choices in the management of local public services have also been studied by Levin and Tadelis [2008] and Lopez de Silanes et al. [1997]. Both studies rely on U.S. data and focus on the determinants of privatization. Levin and Tadelis [2008] empirically observe among other things that a given service is more likely to be privately contracted if a city privatizes one additional other service. However, no explanation of this phenomenon is given. Relying on the French case, Gence-Creux [2001] theoretically explains the concentration of contracts to a same private operator by the electoral concerns of mayors. Our theoretical and empirical results propose an alternative explanation in case of benevolent governments.

Other works in the recent economic literature have explored connected themes. Studying collusion, Bernheim and Whinston [1990] examine the effect of multimarket contacts on the degree of cooperation that firms can sustain in settings of repeated competition. Our methodological approach draws heavily on this work, but our results differ as we show how cooperation can also contribute to the increase of consumers and welfare surplus. The combination of multiple projects under the management of one single manager has also been analyzed by Laux [2001] but in a different setting. Using a principal-agent model, he shows how the bundling of projects can relax the limited liability constraint by allowing punishments for failed projects instead of rewards reducing a manager's rent from each project. Our view is somewhat different in this paper as we emphasize how the bundling of projects can be a rational strategy in a incomplete contract framework by allowing relational contracting. Last, Yurukoglu [2008] shows how the bundling of television channels influences bargaining outcomes between distributors and channels, and increases social welfare through the bundling of (substitute) services responding to the flexible distributions of consumers' tastes . We share the view that the bundling strategy may increase social welfare, however, his modeling approach is different from ours, as he relies on an industry model grounded on institutional detail and historical data. Furthermore, we consider in this papers two services that are independent from each other.

The paper is organized as follows. In a first section (section 2) we present our theoretical framework in a static context. Then, we extend our results to a dynamic context, using a repeated game framework leading to our main propositions (section 3). Then, in a last section (section 4) we present our data and test our propositions. Conclusions follow.

2 The theoretical model

2.1 The general framework

To study the issues at stake, we build a theoretical framework based on Hart et al. [1997]. More specifically, we assume that a benevolent public authority (PA, to whom we will refer to as "she") is in charge of providing two public services to users. We denote these services as $\mathscr{A}$ and $\mathscr{B}$. To provide those two services, we assume that PA has to rely on external operators through the use of contracts.[6]

More precisely, we assume that *ex ante*, PA may describe and specify in a contract some aspects of the provision of a good. However, when executing the contract, the private operator of a service may come up with new innovative ways to adapt the service to users' need, or to reduce the costs of provision of these services. Such innovations are often difficult and costly to anticipate *ex ante*, which leads to some contractual incompleteness as defined by Grossman and Hart [1986], Hart and Moore [1990] or Hart [1995]. Hence, when such innovations turn up, parties will revise the contract *ex post* when it is clear to them what the relevant contingencies are. This leads us to assume that such innovative efforts are *uncontractible ex ante*, but *observable ex post* (and then contractible) once relevant contingencies are realized.

2.1.1 Production technologies

To fix our ideas, we will assume that, *ex ante*, for a given service, the cost of provision incurred by an operator is C_s^0, $s \in \{\mathscr{A}, \mathscr{B}\}$. For simplicity's sake, this cost is assumed to be the same for all operators, and it is known to all. In the same way, we denote the benefits to society that come from the provision of the basic service s as B_s^0, $s \in \{\mathscr{A}, \mathscr{B}\}$. Following Hart et al. [1997], we call this good the "basic" good, and denote its price P_s^0.

Yet, operators may undertake efforts to innovate on the service provided during the execution phase. Two types of innovations are considered: innovations that lead to a reduction in costs, and innovations that lead to a better quality of the provided service. Efforts devoted to cost-reducing innovations (resp. quality-enhancing innovations) for a given service s are denoted e_s (resp. i_s), $s \in \{\mathscr{A}, \mathscr{B}\}$. Upon implementing the innovations, the social benefits and costs of providing a given service s become

$$B_s = B_s^0 - b_s(e_s) + \beta_s(i_s)$$
$$C_s = C_s^0 - c_s(e_s) + i_s + e_s$$

where $c_s(e_s) \geq 0$ is the reduction in costs corresponding to the cost innovation for service s, $b_s(e_s) \geq 0$ is the reduction in quality[7] corresponding to the cost innovations for service s, and $\beta_s(i_s)$ is the quality increases net of costs from the quality innovations for service s, $s \in \{\mathscr{A}, \mathscr{B}\}$. The function b_s measures how much quality is affected because of a (noncontractible) reduction of costs for service s.

For our purpose, we assume that services $\mathscr{A}$ and $\mathscr{B}$ differ in terms of the perspectives for cost-reducing innovations and quality-enhancing innovations. In particular, we assume that for service $\mathscr{A}$, there is no perspective for quality-enhancing innovations, and that cost reductions do not have any impact on the quality of the service provided. In other words, $b_{\mathscr{A}}(e_{\mathscr{A}}) = 0$ and $\beta_{\mathscr{A}}(i_{\mathscr{A}}) = 0$. This means that no ex post renegotiation arises. Indeed, the private manager can implement cost reduction without the approval of the public authority. Moreover, there is no impact on quality, hence PA does not need to ask for renegotiation.
On the other hand, the perspectives of innovation for service $\mathscr{B}$ and their impact on costs and social benefits to the society correspond to the classical case analyzed in Hart et al. [1997], *i.e.* including adverse effects in case of cost reduction, and potential quality innovations. This assumption is meant to capture the fact that cost-reducing perspectives and quality-enhancing opportunities differ across different services. Notice that we also assume that both services are not related in any way.

We make the following standard assumptions on c_s, $b_{\mathscr{B}}$ and $\beta_{\mathscr{B}}$: $b_{\mathscr{B}}(0) = 0$, $b'_{\mathscr{B}}(e_{\mathscr{B}}) \geq 0$, $b''_{\mathscr{B}}(e^{\mathscr{B}}) \geq 0$; $c_s(0) = 0$, $c'_s(0) = \infty$, $c'_s(e_s) > 0$, $c''_s(e^s) < 0$, $c'_s(\infty) = 0$; $\beta_{\mathscr{B}}(0) = 0$, $\beta'_{\mathscr{B}}(0) = \infty$, $\beta''_{\mathscr{B}}(i_{\mathscr{B}}) > 0$, $\beta''_{\mathscr{B}}(i_{\mathscr{B}}) < 0$, $\beta'(\infty) = 0$; $c'_{\mathscr{B}}(e_{\mathscr{B}}) - b'_{\mathscr{B}}(e_{\mathscr{B}}) \geq 0$. The assumptions $c'_{\mathscr{B}}(e_{\mathscr{B}}) - b'_{\mathscr{B}}(e_{\mathscr{B}}) \geq 0$ and $\beta'_{\mathscr{B}}(i_{\mathscr{B}}) > 0$ say that the quality reduction from a cost innovation for service $\mathscr{B}$ does not offset the quality increase.

An operator's overall *ex ante* costs can therefore be written as follows:

$$\text{For service } \mathscr{A} : C^0_{\mathscr{A}} - c_{\mathscr{A}}(e_{\mathscr{A}}) + e_{\mathscr{A}}$$
$$\text{For service } \mathscr{B} : C^0_{\mathscr{B}} - c_{\mathscr{B}}(e_{\mathscr{B}}) + e_{\mathscr{B}} + i_{\mathscr{B}}$$

2.1.2 Contracts

Following the literature, we further assume that $i_{\mathscr{B}}$, $b_{\mathscr{B}}$, $\beta_{\mathscr{B}}$, e_s and c_s, with $s \in \{\mathscr{A}, \mathscr{B}\}$, are observable to the contracting parties, but are not verifiable to outsiders (such as a court). Therefore, these variables cannot be part of an enforceable contract. Furthermore, since these variables are not contractible *ex ante*, PA and the private operator(s) may renegotiate the initial contract, once the innovations are discovered. Similar with Hart et al. [1997], we assume that if the parties renegotiate the contract *ex post*, the gains from renegotiation are divided between them according to a Nash bargaining outcome. The timing of the one shot static game is depicted in the following figure.

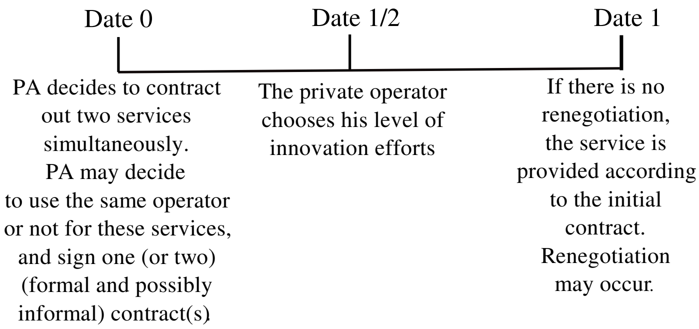

Figure 1: Timing of the game

What is crucial here is that PA may propose an additional informal contract to the operator to share the gains from innovation that are not contracted on ex ante, thus avoiding *ex post* renegotiations. An informal contract here aims to motivate the operator to achieve first-best levels of investments e_s^{FB} and i_s^{FB}, in exchange of a supplementary monetary transfer, denoted T_s from PA to the operator of a given service s. Such a contract, however, may not be enforced by any third party, since innovative efforts are non-verifiable. Consistent with the economic literature, an informal contract is self-enforcing for each party if the payoff stream from cooperation is higher than the payoff stream from deviation (Baker et al. [2002], Baker et al. [2008]). As such the informal contract that we discuss in this paper corresponds to a relational contract. We model such an aspect using a repeated game framework, in which an informal contract is considered to be self-enforcing in the shadow of the future. This issue will be further discussed later on in this paper.

Hence, in our framework, PA is confronted with the decision to whether use a same private operator (the bundling strategy) to ensure the provision of both services, or to delegate the provision of both services to two different operators (the unbundling strategy). Last, we suppose that PA is benevolent, and then will take these decisions to maximize consumers' surplus.[8]

2.2 The first best

We will briefly derive the first-best case to serve as a benchmark. In this situation, we assume contractual completeness for e_s and i_s.

As shown by Hart et al. [1997], contracting parties will choose e_s and i_s to maximize total net surplus from their relationship, and divide the surplus between themselves using lump-sum transfers. As a consequence, first-best incentives are those maximizing:

$$\max_{e_s,i_s} \quad [-b_s(e_s) + c_s(e_s) + \beta_s(i_s) - e_s - i_s]$$

The first best level of efforts for cost-reducing innovations e_s^{FB} and for quality-enhancing innovations i_s^{FB} for service s are therefore characterized by the following:

$$\begin{aligned} b_s'(e_s^{FB}) - c_s'(e_s^{FB}) &= 1 \\ \beta_s'(i_s^{FB}) &= 1 \end{aligned}$$

2.3 The one-shot game

As demonstrated by Hart et al. [1997], using Nash bargaining games, private provision leads to the following payoffs for the public authority:

$$U_s^{PA} = B_s^0 - P_s^0 + \frac{1}{2}\beta_s(i_s) - b_s(e_s)$$

and for the private operator:

$$U_s^{M_s} = P_s^0 - C_s^0 + \frac{1}{2}\beta_s(i_s) + c_s(e_s) - e_s - i_s$$

Maximizing his utility, the private operator of service s chooses e_s^{NB} and i_s^{NB} to satisfy $c_s'(e_s^{NB}) = 1$ and $\frac{1}{2}\beta_s'(i_s^{NB}) = 1$.

Hence, if we compare these results to the first-best case, we see that for service $\mathscr{A}$, the efforts devoted to the cost-reducing innovations are optimal.[9]

However, for the service $\mathscr{B}$, contractual incompleteness leads to overoptimal incentives for efforts devoted to cost-reducing innovations, and under-provision of efforts devoted to quality-enhancing innovations, as shown by Hart et al. [1997]. This is because the private operator does not internalize sufficiently the negative effect of cost-reducing innovations for society, and his incentives for quality-enhancing innovations are dampened by the fact that he only gets half of the benefits of those innovations at the margin.
Granting both contracts to the same operator has *a priori* no effect.[10]. This is resumed in the following proposition:

Proposition 1 *Under a static game, with two services, one with and the other without adverse effects on quality when reducing costs, it is irrelevant for a public authority to consider granting contracts to a same operator or to different operators.*

This proposition is rather straightforward, given our assumption that the services are not related in any way.

3 The repeated game framework

When the agents are in a long term relationship and care about the future, the lack of incentives to invest in i and the over-optimal incentive to invest in e should not be so severe. Such an intuition is based on recent developments on “relational contracts" (Baker et al. [2002], Baker et al. [2008]), *i.e.* informal agreements about observable but non verifiable parameters sustained by the value of future relationships.[11] These works demonstrate that incentives derived from various allocations of ownership may change when concerns for future are taken into account. To this end, the authors use repeated-game models, and show how incentives vary, and how the underpinning informal dealings become self-enforced.

We will follow here such an approach by appealing to the grim trigger strategies framework developed by Friedman [1971].[12] A period in our framework is considered as a contract's duration. As a consequence, at each period, the public authority can choose to continue or to stop the relationship. The discount factor is denoted $0 \leq \delta \leq 1$. Following Halonen [2002], we suppose that parties implicitly agree to make efficient investments, and to share total ex post surplus.

For service $\mathscr{A}$, the first-best is reached even in a static game. Therefore, there is no need of a relational contract to achieve optimal levels of efforts devoted to innovation. However, this is not the case for service $\mathscr{B}$, where private provision leads to over-optimal incentives to reduce costs, and to under-optimal incentives for quality-enhancing investments.

For this service, we therefore suppose that the private manager implicitly agrees to make the first best levels of efforts devoted to innovation e^{FB} and i^{FB}, *i.e.* the levels of efforts that maximize total surplus, but do not maximize his own utility. As a result, the PA's utility is increased, as the adverse effect from cost-reducing innovations is internalized. Let us denote $U_{\mathscr{B}}^{M,FB}$ and $U_{\mathscr{B}}^{PA,FB}$ the utilities of the operator for service $\mathscr{B}$ and of the PA when first-best investments are made during the management of service $\mathscr{B}$. To compensate the decrease in utility of the private operator, the PA promises him a transfer $T_{\mathscr{B}}$ that is paid at the end of each period, *i.e.* when levels of efforts become observable by parties. In case of relational contracting, final payoffs of each party are then:

$$\begin{aligned} U_{\mathscr{B}}^{M,R} &= U_{\mathscr{B}}^{M,FB} + T_{\mathscr{B}} \\ U_{\mathscr{B}}^{PA,R} &= U_{\mathscr{B}}^{PA,FB} - T_{\mathscr{B}} \end{aligned}$$

Note that the only relevant information about the previous period is whether there has been any deviation or not. It then remains to determine what kind of transfer $T_{\mathscr{B}}$ (*i.e.* sharing of the surplus) allows such a relational contract to be respected by both contracting partners.[13] To this end, let us first precise what the trigger strategy means here:

- Either each partner accepts the relational agreement, *i.e.* the private manager makes optimal levels of investments. He receives a transfer from the public authority. There is no reason for the relationship to be terminated as first-best is achieved.
- Else, one of the partners reneges. If the private operator cheats, he prefers to invest to maximize his own utility, *i.e.* he prefers to have $U_{\mathscr{B}}^{M,NB}$ than $U_{\mathscr{B}}^{M,R}$. However, from this point, he is no longer considered as trustworthy. This means that the PA will select him again for the subsequent periods with a probability $0 \leq p \leq 1$, and will refuse to contract with him with a probability $(1-p)$.[14]
- If the public authority reneges, *i.e.* refuses to give the transfer while the private manager has made first-best incentives, then the latter applies nash bargaining rules for the rest of the

game. If he is chosen for the following periods, he will not accept any informal dealing, and return to the non-cooperative solution.

As in the static game, $P^0_{\mathscr{B}}$ represents the (*ex ante*) price paid by the public authority to the private manager to provide the service. As $T_{\mathscr{B}}$ is the *ex post* transfer given to the private manager, the total price paid by the public authority when relational contracting is honored on both sides is $P^0_{\mathscr{B}} + T_{\mathscr{B}}$ for service $\mathscr{B}$.

First best will be supported in equilibrium only if the discounted payoff stream from efficient behavior exceeds the payoff stream from the deviation path for both agents. We will show that when two contracts - one with and the other without adverse effect - are signed by the same partners, the level of transfer $T_{\mathscr{B}}$ is lower than when only one contract is delegated. As a consequence, the total price is lower in case of bundling than in case of unbundling.

3.1 The "unbundling" strategy: A different operator for each service

3.1.1 Share of the uncontractible surplus

Suppose that the public authority has chosen a different operator for each service. For the service $\mathscr{A}$, there is no relational agreement to implement to achieve first-best, as incentives of the private manager correspond to the optimal levels, even in the one-shot game. The total price paid by the public authority is then $P^0_{\mathscr{A}}$, as described in the previous part.

For service $\mathscr{B}$, first-best levels of incentives are achieved if the relational contract described above is implemented. Beyond the formal contract signed *ex ante* for a price $P^0_{\mathscr{B}}$, an informal dealing is agreed on by the partners. Let us denote $T_{\mathscr{B}}$ the transfer of the public authority to the private manager in this case. We try to determine the level of such a transfer.[15] As just mentioned, first-best will be supported in equilibrium if, for both partners, the discounted payoff stream is higher under relational contracting than under the deviation path, *i.e.* :

- for the private manager:

$$\frac{U^{M,FB}_{\mathscr{B}} + T_{\mathscr{B}}}{1-\delta} \geq U^{M,NB}_{\mathscr{B}} + \frac{\delta p U^{M,NB}_{\mathscr{B}}}{1-\delta} \tag{1}$$

Indeed, the private manager obtains $U^{M,NB}_{\mathscr{B}}$ when he deviates, and then receives $\frac{\delta p U^{M,NB}_{\mathscr{B}}}{1-\delta}$

(See appendix A for demonstration).

- for the public authority:

$$\frac{U_{\mathscr{B}}^{PA,FB} - T_{\mathscr{B}}}{1-\delta} \quad \geq \quad U_{\mathscr{B}}^{PA,FB} + \frac{\delta p U_{\mathscr{B}}^{PA,NB}}{1-\delta} + \frac{\delta(1-p)U_{\mathscr{B}}^{PA,oo}}{1-\delta} \tag{2}$$

where $U_{\mathscr{B}}^{PA,00}$ represents the utility of the public authority derived from her outside option, *i.e.* either public provision or the selection of another private manager for the next periods (with or without informal dealings). Gain from deviation for the public authority is $U_{\mathscr{B}}^{PA,FB}$, as he chooses not to give the transfer to the private manager the bonus and benefits from the optimal investments. It follows that the private manager will no longer trust the PA if he is selected again (with probability p) for the next periods.

Equation 1 allows us to show that $T_{\mathscr{B}}$ is lower bounded:

$$T_{\mathscr{B}} \quad \geq \quad \delta(p-1)U_{\mathscr{B}}^{M,NB} + U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB} \tag{3}$$

As a result, when $T_{\mathscr{B}}$, *i.e.* the bonus paid by the public authority to the private manager when the relational contract is honored, is at least equal to $\delta(p-1)U_{\mathscr{B}}^{M,NB} + U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}$, the relational contract is self-enforced for the private manager.[16] Then, equation 3 is the incentive compatibility for the private manager.

Let us note that the lower the transfer is, the lower temptations to deviate are for the party that gives the transfer. Moreover, since PA only cares about consumers' surplus, she will have an interest to pay the lowest possible transfer.[17] Therefore, $T_{\mathscr{B}}^{*}$ is such as 3 is just satisfied, *i.e.* :

$$T_{\mathscr{B}}^{*} = [\delta(p-1)]U_{\mathscr{B}}^{M,NB} + U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}$$

3.1.2 Total cost for the public authority

The total total cost for PA to provide both services is then:

- $P_{\mathscr{A}}^{0}$ for the service $\mathscr{A}$

- $P_{\mathscr{B}}^{0} + T_{\mathscr{B}}^{*}$, *i.e.* the *ex ante* price $P_{\mathscr{B}}^{0}$ and the *ex post* surplus, for service $\mathscr{B}$

Denoting P^U, the total cost for both services, we have $P^U = P^0_{\mathscr{A}} + P^0_{\mathscr{B}} + T^*_{\mathscr{B}}$.

3.2 The "bundling" strategy: A same private operator

3.2.1 Share of the uncontractible surplus

Suppose now that both services are bundled, *i.e.* a same private operator is managing them. Let us determine the sharing rule $T_{\mathscr{A}+\mathscr{B}}$ of the surplus that allows to make relational contract self-enforced.

In a similar way to the previous case, the private manager either accepts the sharing rule $T_{\mathscr{A}+\mathscr{B}}$, or deviates and prefers Nash bargaining rules. As a consequence, the public authority will select him again for each service with a probability $0 \leq p \leq 1$. Yet, contrary to the case of unbundling, punishment is here applied to both contracts: when the private partner deviates, the public authority applies his sanction, *i.e.* the probability p to be chosen again at subsequent periods, on contracts for both services $\mathscr{A}$ and $\mathscr{B}$.

As a consequence, when the informal dealing is respected, the private manager's utility $U^{M,R}_{\mathscr{A}+\mathscr{B}}$ is:

- The utility derived from the contract for service $\mathscr{A}$, *i.e.* $U^{M,FB}_{\mathscr{A}} = U^{M,NB}_{\mathscr{A}}$, as first-best is achieved through Nash bargaining
- And the utility of the second contract with first-best investments plus the bonus, *i.e.* $U^{M,FB}_{\mathscr{B}}$ + $T_{\mathscr{A}+\mathscr{B}}$

As a consequence, $U^{M,R}_{\mathscr{A}+\mathscr{B}} = U^{M,NB}_{\mathscr{A}} + U^{M,FB}_{\mathscr{B}}$ + $T_{\mathscr{A}+\mathscr{B}}$.

In case of deviation, he gains on the contract for service $\mathscr{B}$[18], *i.e.* $U^{M,NB}_{\mathscr{B}}$, but would be selected again for the other periods with a probability p, for both contracts. As a result, the private manager honors his informal agreement when:

$$T_{\mathscr{A}+\mathscr{B}} \geq (U^{M,NB}_{\mathscr{A}} + U^{M,NB}_{\mathscr{B}})\delta(p-1) + (U^{M,NB}_{\mathscr{B}} - UM^{M,FB}_{\mathscr{B}})$$

In the same way as our discussion above, PA will want to choose the lowest possible amount of transfer in order to maximize consumers' surplus. Furthermore, the lower the transfer is, the lower temptations to deviate are for the public authority that has to give the amount of transfer. As a consequence, when both contracts are bundled:

$$T^*_{\mathscr{A}+\mathscr{B}} = (U^{M,NB}_{\mathscr{A}} + U^{M,NB}_{\mathscr{B}})\delta(p-1) + (U^{M,NB}_{\mathscr{B}} - UM^{M,FB}_{\mathscr{B}})$$

Let us now compare the strategies of bundling and unbundling.

3.2.2 Total cost for the public authority

In case of bundling, the total cost for PA is therefore:

- $P^0_{\mathscr{A}}$ for service $\mathscr{A}$
- $P^0_{\mathscr{B}} + T_{\mathscr{A}+\mathscr{B}}$, *i.e.* the *ex ante* price $P^0_{\mathscr{B}}$ and the *ex post* surplus, for service $\mathscr{B}$

Denoting P^I such a cost, we have $P^I = P^0_{\mathscr{A}} + P^0_{\mathscr{B}} + T_{\mathscr{A}+\mathscr{B}}$.

3.3 Cost comparison and proposition

Let us now compare the total cost in each case:

- In case of unbundling, the total cost paid by the public authority is $P^U = P^0_{\mathscr{A}} + P^0_{\mathscr{B}} + T^*_{\mathscr{B}}$, *i.e.*
$$P^U = P^0_{\mathscr{A}} + P^0_{\mathscr{B}} + \delta(p-1)U^{M,NB}_{\mathscr{B}} + U^{M,NB}_{\mathscr{B}} - U^{M,FB}_{\mathscr{B}}$$
- In case of bundling, the total cost paid by the public authority is $P^I = P^0_{\mathscr{A}} + P^0_{\mathscr{B}} + T_{\mathscr{A}+\mathscr{B}}$, *i.e.*
$$P^I = P^0_{\mathscr{A}} + P^0_{\mathscr{B}} + \delta(p-1)(U^{M,NB}_{\mathscr{A}} + U^{M,NB}_{\mathscr{B}}) + (U^{M,NB}_{\mathscr{B}} - UM^{M,FB}_{\mathscr{B}})$$

Parameters defining P^I and P^U are the same ex ante prices $P^0_{\mathscr{A}} + P^0_{\mathscr{B}}$, and the same final terms $U^{M,NB}_{\mathscr{B}} - UM^{M,FB}_{\mathscr{B}}$. Differences are then the first terms on the right of the equation $(U^{M,NB}_{\mathscr{A}} + U^{M,NB}_{\mathscr{B}})\delta(p-1)$ and $\delta(p-1)U^{M_{\mathscr{B}},NB}_{\mathscr{B}}$.

With $0 \leq p \leq 1$, $(U^{M,NB}_{\mathscr{A}} + U^{M,NB}_{\mathscr{B}})\delta(p-1) \leq \delta(p-1)U^{M,NB}_{\mathscr{B}}$, then $P^I \leq P^D$.

Proposition 2 *When two services - one with and another without adverse effect- are concentrated in the hands of one single operator, it leads to lower prices that the public authority needs to pay, compared to the situation where both services are contracted out to different private firms.*

In the following section, we propose an empirical analysis to see whether this result is consistent with what can be observed in some data about water sector.

4 An empirical analysis of bundling in the French water sector

4.1 Putting the Model to the test

Before turning to the empirical analysis, we address some preliminary issues of interpretation. Our baseline model focuses on two types of services, one with and the other without adverse effect on quality in case of uncontractible cost reduction. It points out that bundling, *i.e* the provision of two services by a same private operator, facilitates the enforcement of relational contracts.

Putting our theory to the test implies to find at least one service whose uncontractible cost-reducing investments do not impact on quality (service $\mathscr{A}$ in our model). This is a very strong empirical challenge, as it implies some "limited" contractual incompleteness, *i.e.* a service for which cost-reducing investments cannot be contracted on ex ante, but never damage quality. This seems difficult to find. Nevertheless, it is straightforward to see that our results can be extended to the case of two services, one whose uncontractible cost reductions are likely to entail strong adverse effects on quality, while the other is likely to generate weak adverse effects. Matching our theory to the data therefore requires us to consider two services - one with *high* and the other with *low* adverse effects on quality in case of uncontractible cost reduction. In such a case, our model suggests that prices paid by public authority are likely to be lower in case of bundling than in case of unbundling, and this is the main proposition we will test. To evaluate the empirical relevance of such a proposition, we draw our attention to the French water sector.

Indeed, the water sector appears to provide a particularly interesting testing ground for our proposition because there are two types of water services that a municipality has to provide to consumers: drinking water services and waste water (or sanitation) services. The provision of the former service involves producing and distributing drinking water to the population, while the latter involves collecting used water and treating it in an adequate way. Moreover, we observe that generally, firms that provide one of these services can provide the other service.

In addition, quality is a more sensible topic of concern for drinking water than for waste water services. Sanitary risks exist in both cases but because of public safety dimensions related to drinking water, the population is more able to observe quality in this service than in sanitation service. As a consequence, municipalities may be more concerned with providing adequate incentives to ensure the quality of drinking water provided to the population, in contrast with the quality of treatment for waste water, especially regarding their willingness to comply with citizen's complaints in order to be reelected. Differences between both services may also be highlighted by looking at the number of norms that regulate the quality of drinking water and the quality of waste water. For instance, the European Council Directive 98/83/EC (Official Journal OJ L 330 of 05.12.1998) of 3 November 1998 on the quality of water intended for human consumption defines a number of about 53 norms that drinking water is subjected to. In contrast, the European Council Directive 91/271/EEC of 21 May 1991 concerning urban waste water treatment defines only about 5 norms for waste water treatment. This may suggest that control for quality in drinking water can be costly and more complicated than for waste water. We may therefore think that adverse quality effects may be more limited in waste water services than drinking water services. As such, the industry is close to the theoretical case we study.

The French case is also interesting because of the *intuitu personae* principle that regulates contracts between public and private partners (called "public-private partnerships" hereafter). As recalled in the introduction, a municipality that organizes a call for tender is not legally obliged to publish any objective or subjective criteria for selecting the winning tender (Auby [1997]). Public authorities are allowed to negotiate with the potential entrants, before choosing the final partner. Such a freedom granted to public authorities allows to introduce subjective elements during the decision process, and to customize the relationships between public and private partners. This leaves naturally room for informal dealings between contractors. They may sustain corruption practices that have been already explored in previous words on public procurement (Compte et al. [2005], Maskin and Tirole [2007]). Our model shows how this informal dimension can also open the door to highly potential relational agreements that allow to achieve optimal incentives to invest.[19]

4.2 The data

In order to test our main proposition, which points out that prices for drinking water services should be lower when the same operator is being used to provide for the two types of water services, we have developed a unique panel dataset by combining data from the French Environment Institute (IFEN) and the French Health Ministry (DGS), on 4987 local public authorities in 1998, 2001

Table 1: Description of our variables

Variable	Description	N	Mean	Std. Dev.	Min	Max
Price	Price of water per 120m^3	7002	160.58	45.88	52.44	299.53
IdentDateSign	Takes value 1 if an identical operator is used for drinking water and sanitation services, and if contracts are signed the same year	7002	0.31	0.46	0	1
TreatA1	Takes value 1 when raw water does not need a desinfection treatment	7002	0.52	0.5	0	1
TreatA2	Takes value 1 when raw water needs a desinfection treatment	7002	0.17	0.38	0	1
Orig1	Takes value 1 when water comes from an underground source	7002	0.16	0.36	0	1
Orig2	Takes value 1 when raw water comes from a source on the surface	7002	0.21	0.41	0	1
Interco	Takes value 1 if the local authority is organizing the distribution of water in cooperation with other local authorities	7002	0.74	0.44	0	1
Density	Number of Km of network / Number of Inhabitants	7002	7.96	19.04	0	228.25
Pop	Size of the population/10 000	7002	0.98	4.92	0	212.52
Pop2	Square of Pop	7002	25.17	939.26	0	45166.7
RenewProg	Takes value 1 if there is a program investment program	7002	0.63	0.48	0	1
Scarcity	Total volume distributed / (total volume distributed + imported volume)	7002	0.88	0.24	0	1
Limitation	Takes value 1 if consumed volume of water is constrained by reglementation at some period of time during the year	7002	0.07	0.26	0	1
Tourist	Takes value 1 if the municapality is a tourist zone	7002	0.13	0.34	0	1
LeftWing95	Percentage of votes for left wing parties in the 1995 French presidential elections	6982	0.47	0.08	0.08	0.79
LeftWing02	Percentage of votes for left wing parties in the 2002 French presidential elections	6994	0.33	0.07	0.04	0.7
D85	Takes value 1 if a contract is signed before 1985	7002	0.17	0.37	0	1
D8593	Takes value 1 if a contract is signed between 1985 and 1993	7002	0.24	0.43	0	1
D93	Takes value 1 if a contract is signed after 1993	7002	0.59	0.49	0	1
Instrument1	Average prevalence of bundling with the same operator at the time of contracting in different regions	7002	0.15	0.09	0	0.36
Instrument2	Average prevalence of bundling at the time of contracting in different regions	7002	0.53	0.15	0	0.65

and 2004, yielding a sample size of 14 961 data points.[20] This sample is representative of the total population of French local public authorities: all sizes of local authorities are proportionally represented, with the exception of large local authorities (more than 10 000 unhabitants) that are all included in the sample.[21] Eliminating observations with missing data and focusing only on those municipalities whose services are managed through Public Private Partnerships reduces our sample to a total 7002 observations over the three years, representing about 2973 municipalities. The unit of observation is a municipality. The following table (Table 1) provides definitions of all variables used in the empirical model along with descriptive statistics.

We are interested in the impact on water prices of the choice of an identical operator for both water distribution and sanitation services. The share of municipalities that have made such a choice is shown in table 2: about 53,63% of our observations correspond to the case where an identical operator runs both drinking water and sanitation services. This simple observation seems to point out that the bundling of contracts is rather common in the French water sector. Indeed, a crude approximation assuming that choices are randomly made among the three main operators available at national level would lead to a concentration rate of about 33%.[22] Interestingly, the table also shows that when contracts for both services arrive at termination the same year (which implies that municipalities have to select operators for these two services the same year), many of them (about 88.65%) choose an identical operator. This seems to suggest that whenever it is possible for a municipality to renew the two contracts with an identical operator, they tend to do so. This latter observation is consistent with a first implication of our model, *i.e.* contracts bundling should be used whenever possible in order to sustain relational contracts.

Table 2: Share and average water prices of French municipalities using the same operator for drinking and sanitation services

	Signed at different years	Signed the same year	Total	Average price			
				1998	2001	2004	All
Different operators	2988	259	3247	157.32	166.48	177.28	167.06
Same operator	1731	2024	3755	146.89	153.52	164.61	154.99
Total	4719	2283	7002	151.71	159.52	170.51	160.58

Furthermore, a look at the average water prices shows that these prices are lower when an identical operator has been chosen, compared to the situation where two different operators run the services. A simple Student test confirms that the difference is significant for 2001, 2004 and on the overall.[23] These observations allow us to suspect that the choice of using an identical operator is not random and is not neutral on the level of price for water services.

4.3 Linking the model with the data

Our theoretical model suggests that bundling services helps sustaining relational contracting between parties and is therefore welfare enhancing. One of the implications of our theoretical analysis for the water industry is that water prices should be lower when an identical operator is used. As we have seen, simple statistics computed above seem to suggest that such an effect exists. Nevertheless, we must take into account the fact that each local authority is unique: each water service is characterized by a specific environment that may also impact on prices and their evolution (*e.g.*

characteristics of the networks, size of the population, ...). Therefore, to test the implications of our model, we need to estimate the *ceteris paribus* effect on price when services are bundled. To ascertain the impact of contracts bundling on water prices, we estimate the following price equation:

$$p = D\delta + X\beta + T\eta + u \; with \; u \rightsquigarrow (0, \Sigma)$$

where p is price per 120m^3 of water, D is an indicator that takes value 1 if both services are provided by the same firm, X is a set of exogenous factors characterizing each service, T is a set of exogenous controls, and u is the (heteroskedastic) stochastic error.

We are interested in the coefficient δ which represents the effect of bundling. In order to assess the impact of this bundling strategy on water prices, we use the variable *IdentDateSign* which indicates whether an identical operator is used by a municipality and whether contracts for both services are signed the same year. Our analysis implies that this variable should have a negative impact on water prices. The exogenous control variables in our regression can be found in table 1. Basically, these variables capture the characteristics of the water distribution network as well as characteristics of a given municipality.[24] Year fixed effects and operator fixed effects are also included as exogeneous control variables. We first use the OLS estimator to estimate the price equation. To further account for any unobservable heterogeneity among municipalities, we will also exploit the panel dimension of our data and estimate a fixed effect model using the within estimator.

4.3.1 Addressing Possible Synergies between Services

We should note that another plausible explanation for lower water prices when services are bundled could stem from the existence of economies of scale and/or scope between both services. Indeed, if there are economies of scale and/or scope between water production and waste water services, an operator in charge of both services may exploit the synergies between the two activities, leading to lower prices. This should be the case when competition for the market is important enough.[25] This is a challenge that we should address in our empirical work, even if previous empirical studies seem to find little evidence of synergies between both types of activity.[26] In what follows, we discuss how this issue may be dealt with in our empirical estimations.

First of all, we control for the presence of economies of scale in drinking water services by including in our regression a variable measuring the production scale of the services. The population in a municipality and its square may serve such a purpose. Indeed, the larger the population, the higher the volume of water that needs to be produced. Moreover, the quadratic term is a classic way of picking up possible scale economies in applied econometric analyses. Likewise, we will include the variable *density* which measures the density of the water distribution network as a means to address possible economies of density.

If some synergies between drinking water services and sanitation services exist, there is no reason to consider that they should not be constant over time. Thus, the within estimator that we use should neutralize those potential synergies (if any) that may have an impact on water prices. In addition, we will explore in our regression the impact of *IdentDateSign* on the first difference of water prices. Just like the within estimator, taking the first difference of water prices as our independent variable instead of the level of water prices should neutralize those synergies that are constant throughout time between both services. Moreover, this approach follows the "spirit" of the model, whereby in presence of relational contracting, unanticipated *ex post* renegotiations between the parties may be facilitated.[27] When renegotiations are costly and in presence of relational contracting, price variations due to these renegotiations should be weaker. We then expect that the bundling strategy has a negative impact on price variation, as it helps contracting parties to sustain relational contracts.

Lastly, we will also include the lagged water price in our regression as a proxy for cost of running the drinking water services.[28] This is because any synergy would be reflected in the cost of services and water prices are correlated with such cost. As such, this variable is likely to pick up the presence of synergies in the regressions. Nevertheless, the inclusion of this variable would lead to an endogeneity problem in our fixed effect panel regression. To account for this, we use an instrumental variable method for dynamic panel data proposed by Anderson and Hsiao [1981]. This method consists in first-differencing the equation to be estimated in order to remove the unobserved heterogeneity term, and then use the twice-lagged independent variable ($\text{Price}_{i,t-2}$) as an instrument to estimate the model using the transformed data.

4.3.2 Addressing Authorities' Choice endogeneity

Indeed, another econometric difficulty that may arise is the possibility that *IdentDateSign* is endogeneous. In particular, there may be individual heterogeneity across local public authorities or private operators that is unobserved by the econometrician, but that is correlated with both relationship choice and performance. In this case, OLS estimates of the specification above will be biased and inconsistent.

Thus, to obtain unbiased estimates of the impact of (endogenous) the bundling decision on water prices, we estimate a system of equations accounting for the endogeneity and allowing for cross-equation correlation in the errors:

$$\begin{aligned} p &= D\delta + X\beta + T\eta + u \\ D^* &= X\alpha + T\lambda + Z\gamma + v \end{aligned}$$

$$D = \begin{cases} 1 & if\ X\alpha + T\lambda + Z\gamma \geqslant v \\ 0 & if\ X\alpha + T\lambda + Z\gamma \prec v \end{cases}$$

Here *D* is our potentially endogeneous variable *IdentDateSigne*. The *D* equation is normalized by the standard deviation of *v*, and we assume that (*p D*) is distributed bivariate normal with mean zero and variance-covariance:

$$\Gamma = \begin{bmatrix} \sigma_u^2 & \sigma_{uv} \\ \sigma_{uv} & 1 \end{bmatrix}$$

This procedure accounts for the endogeneity in the choice, *D*, and yields unbiased estimates of δ, the unconditional mean premium or discount paid by consumers in a municipality that has chosen to bundle horizontally both services.

For our Probit regression on *IdentDateSign*, the *Z* variables which are included are *Regional dummy variables*, and the percentage of votes for left-wing candidates the 1995 and 2002 French presidential elections in a given municipality (resp. the variables *Left95* and *Left02*). A “Région” is the most important political entity in which a local public authority is situated. These variables are intended to capture political and ideological aspects of using relational contracts by a municipality. Since these are political and ideological motivations on the choice of relational contracts, one may argue that they do not have a direct impact on water prices and could therefore be considered as instruments. We will also include as *Z* variables a set of dummy variables indicating the period in which the contract for water services has been signed (before 1982, between 1982 and 1993 and after 1993). These dates correspond in fact to some major changes in the French legislation on the organization and the provision of public services.[29] The laws may have a direct impact on the decision to bundle both services, and a more indirect impact on water prices (since they do not directly regulate prices). As such, we may consider these variables as valid instruments for *IdentDateSign*.

Lastly, following Guasch et al. [2008], for each of our water contracts we computed the average prevalence of bundling with the same operator at the time of contracting in different regions (*Instrument1*) and the average prevalence of bundling at the time of contracting in different regions (Instrument2). These instruments are valid because the correlation between the choice to bundle contracts for a project with a specific operator in a given Region is only correlated to instrument 1 through aspects, which by construction are independent of Region specific aspects. Similarly, the choice to bundle or not contracts is only correlated to instrument 2 through aspects, which by construction are independent of both Region and operator specific effects.

4.4 Estimation results

Results of our estimation are shown in table 3. We run OLS regresssions on the price of water for each year of our sample in columns (1) to (3), and on the whole sample in columns (4) to (7). In these latter columns, we respectively add the lagged water prices (column (5)), and we use the first difference in water prices (column (6)). Column (7) shows the estimation results when we take into account the panel dimension of our data by using the within estimator.[30] Finally, column (8) implements the Anderson and Hsiao estimator, where the data are first-differenced, and where the lagged explanatory variable (lagged price) is instrumented by price of water in 1998. [31] In our panel regressions, some of the variables are absent from the model. This is the case for *Pop*, *Pop2* and *Density*. This is due to the fact that we only have information for these variables on a given year. There is therefore no variation in time for these variables.

Table 3: Regression results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Price	Price	Price	Price	Price	ΔPrice	Price	Price
Sample	1998	2001	2004	Pooled	Pooled	Pooled	Pooled	Pooled
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	Within	Anderson-Hsiao
IdentDateSign	-5.021**	-5.988**	-10.296***	-7.048***	-4.284***	-2.266+	-4.050**	-3.711*
	(1.899)	(1.859)	(1.907)	(1.080)	(1.049)	(1.160)	(1.571)	(1.672)
Price_{t-1}					0.663***		-0.136***	-0.111***
					(0.020)		(0.017)	(0.018)
TraitA1	-3.158	-2.788	-4.871+	-3.520*	-0.211	1.717	6.107**	5.577*
	(2.523)	(2.624)	(2.689)	(1.438)	(1.397)	(1.571)	(2.277)	(2.443)
TraitA2	6.154*	5.171*	2.924	4.427**	1.402	0.182	2.697	1.685
	(2.558)	(2.466)	(2.686)	(1.415)	(1.341)	(1.539)	(1.944)	(2.064)
Orig1	11.657***	10.588***	10.820***	11.015***	2.338	-1.767	6.932+	4.888
	(3.058)	(3.038)	(3.242)	(1.756)	(1.662)	(1.866)	(3.884)	(3.898)
Orig2	3.095	-1.041	-0.925	0.730	-1.075	-1.025	3.558	0.788
	(2.758)	(2.803)	(3.097)	(1.612)	(1.495)	(1.648)	(3.094)	(3.194)
Interco	23.630***	25.042***	18.498***	22.522***	5.288***	-3.119**	4.698+	3.038
	(1.979)	(1.999)	(2.336)	(1.190)	(1.149)	(1.123)	(2.446)	(2.455)
Density	-0.119**	-0.075+	-0.125*	-0.119***	-0.014	0.026		
	(0.046)	(0.041)	(0.051)	(0.026)	(0.023)	(0.025)		
Pop	-1.959***	-2.726***	-3.684***	-1.914***	-1.198***	-0.258		
	(0.565)	(0.766)	(0.759)	(0.377)	(0.361)	(0.394)		
Pop2	0.028***	0.113**	0.101***	0.035**	0.030**	-0.002		
	(0.008)	(0.040)	(0.022)	(0.011)	(0.011)	(0.012)		
RenewProg	0.118	0.359	-0.070	-0.097	-0.214	-0.364	-0.726	-0.970
	(1.668)	(1.806)	(1.984)	(0.986)	(0.896)	(0.975)	(0.922)	(0.958)
Scarcity	-9.771***	-8.134*	-9.678*	-8.730***	-5.164*	-3.441	-4.620	-0.399
	(2.924)	(3.549)	(3.929)	(1.924)	(2.073)	(2.347)	(3.562)	(3.814)
Limitation	3.071	-1.940	0.072	-0.362	1.714	3.355*	-1.906	-1.840
	(3.931)	(6.045)	(2.814)	(1.877)	(1.515)	(1.629)	(1.349)	(1.393)
Tourist	-0.111	0.045	-0.737	0.263	0.055	0.087	5.589*	5.326*
	(2.503)	(2.477)	(2.702)	(1.463)	(1.266)	(1.358)	(2.617)	(2.692)
Constant	132.549***	139.483***	144.701***	147.775***	56.183***	10.795	193.239***	13.268***
	(9.552)	(11.025)	(13.454)	(6.753)	(8.015)	(8.285)	(8.249)	(0.599)
Year fixed effects	No	No	No	Yes	Yes	Yes	Yes	No
Département fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Operator fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.508	0.479	0.441	0.466	0.704	0.095	0.235	
N	2308	2378	2316	7002	4694	4694	4694	1730

Standard errors within parentheses. For regressions using the OLS estimator, Huber/White/Sandwich standard errors are given.
Significance level: + 10% *5% ** 1% *** 0.1%.

As one may see from table 3, our variable of interest turns out to be significant across all specifications. The estimations suggest that the decision to bundle contracts leads to a negative impact on the water price. The impact is between 5 to 10 euros when regressions are run using only data for a given year (columns (1) and (3)), and around 7 euros (column (4)) when considering the data over the three periods corresponding to a reduction of more than 5% of the observed average bill. While the size of this effect is diminished when we account for possible fixed effects and when we add the lagged price into the regression as a proxy for the cost structure of running the service, it persists nevertheless. Interestingly, even if we look at whether there is an impact of this variable on the variation of water prices between periods, the estimations lead to a negative and significant impact (column (6)). As prices for water tend to increase over time, this means that price increases tend to be smaller when an identical operator is selected for both services and when contracts for both drinking water and sanitation services are signed the same year with the operator, *ceteris paribus*. All these observations are consistent with the prediction of our theoretical model, according to which contracts bundling should help sustaining relational contracts and gives incentives for contracting parties to improve efficiency of trade leading to a price reduction.

As we have mentioned, an alternative explanation for this negative effect of *IdentDateSign* could come from possible synergies across drinking water and sanitation services. As we pointed out previously, we have tried to control for possible economies of scale and scope in these regressions, using the size of the population and the density of the distribution network. In spite of these controls, the negative effect of *IdentDateSign* persists.

Another way to control for synergies is to take into account the cost structure of a service in a municipality. A proxy for cost structure is the lagged water prices, which is included in regressions (columns (5, 7 and 8)). By first-differencing our dependent variable and/or by exploiting the within estimator to account for any fixed municipal effects, we partly neutralize such synergies (columns 5, 6 and 7). Results are not affected if we account for the possible endogeneity stemming from the lagged water price in the panel regression using the Anderson-Hsiao estimator (column (8)). *IdentDateSign* remains significant with the expected effect on water prices whatever the specification retained. Those specifications allow us to capture one of the aspects of relational contracting, *i.e.* renegotiations are less costly and reflect in lower prices when the same operator is providing both services. Hence, we are quite confident that the remaining effect on water prices as estimated by *IdentDateSign* reflects something else besides synergies in these specifications.

Table 4: Results of our switching regressions

	(A)		(B)	
Dependent variable	IdentDateSign	Price	IdentDateSign	Price
Estimator	Probit	OLS	Probit	OLS
Price_{t-1}		0.672***		0.672***
		(0.010)		(0.010)
IdentDateSign		-7.290**		-7.215**
		(2.491)		(2.472)
TreatA1	-0.229**	0.253	-0.222**	0.262
	(0.070)	(1.276)	(0.070)	(1.276)
TreatA2	-0.220**	1.846	-0.218**	1.856
	(0.071)	(1.264)	(0.071)	(1.263)
Orig1	0.213*	3.470*	0.237**	3.478*
	(0.084)	(1.590)	(0.084)	(1.590)
Orig2	-0.183*	-0.973	-0.182*	-0.961
	(0.076)	(1.405)	(0.077)	(1.404)
Interco	-0.561***	4.619***	-0.560***	4.630***
	(0.052)	(1.085)	(0.052)	(1.084)
Density	-0.013***	-0.024	-0.013***	-0.024
	(0.003)	(0.037)	(0.003)	(0.036)
Pop	0.080**	-1.017*	0.084***	-1.018*
	(0.025)	(0.397)	(0.025)	(0.397)
Pop2	-0.002*	0.025+	-0.002*	0.025+
	(0.001)	(0.014)	(0.001)	(0.014)
RenewProg	-0.023	-0.072	-0.016	-0.069
	(0.047)	(0.857)	(0.047)	(0.857)
Scarcity	0.287**	-5.048**	0.311**	-5.057**
	(0.102)	(1.863)	(0.102)	(1.863)
Limitation	0.021	1.916	0.022	1.913
	(0.079)	(1.454)	(0.080)	(1.454)
Tourist	0.318***	0.413	0.314***	0.406
	(0.065)	(1.246)	(0.065)	(1.246)
LeftWing95	0.954+		0.984*	
	(0.499)		(0.500)	
LeftWing02	0.453		0.417	
	(0.492)		(0.493)	
D85	-0.597***		-0.429***	
	(0.079)		(0.092)	
D93	0.151**		0.151**	
	(0.053)		(0.054)	
Instrument1			-1.308+	
			(0.672)	
Instrument2			1.235***	
			(0.365)	
Constant	-2.293***	54.834***	-1.059*	54.837***
	(0.573)	(6.561)	(0.534)	(6.561)
Year fixed effects	Yes	Yes	Yes	Yes
Département fixed effets	No	Yes	No	Yes
Region fixed effects	Yes	No	Yes	No
Operateur fixed effects	Yes	Yes	Yes	Yes
ρ	0.076		0.074	
	(0.058)		(0.057)	
N	4672		4672	

Standard errors within parentheses.

Significance level: + 10% *5% ** 1% *** 0.1%.

One may rightfully worry that the decision to use an identical operator may be endogenous. Estimation attempting to account for this is given in table 4. Again, after accounting for the fact that *IdentDateSign* may be endogenous, the negative effect remains significant. The changes in legislation seem to have a significant impact on a municipality's decision of an identical operator. A test on the various regional dummy variables also shows that these are jointly significant. Lastly, the inter-equation correlation ρ is not significantly different from 0, suggesting that *IdentDateSign* may not be endogenous.

In a nutshell, our estimation results show that water prices are lower when an identical operator is used and when contracts for drinking water and sanitation services are signed the same year. Even after controlling for possible sources of synergies between both services that may explain this, this effect is persistent. These observations do not lead us to reject the implications of our theoretical model.

5 Conclusion

In this article, we seek to understand why local public authorities tend to concentrate the provision of various services in the hands of one single operator. We suggest that such a bundling strategy may be desirable because it enhances the efficiency of relational contracts between local public authorities and private operators. This does not imply to bundle all services, but justifies why there may be some interest to bundle two (or more) services with different cost characteristics, so as to limit the damages on quality caused by contractual incompleteness. To show this, we proposed a model based on the incomplete contract literature. We then show that under some conditions, the bundling of services leads to a better performance at lower cost for the public authority. This can be explained by the fact that relational contracts are more easily sustained in the latter case, as deviations from the relational contracts can be more severely punished. We then look at the empirical relevance of our findings using data from the French water sector. In particular, our regressions show that drinking water prices are significantly lower when a same operator is in charge of providing waste water services, *ceteris paribus*. This empirical result is robust to several specifications and consistent with our story on relational contracts.

On the whole, our study suggests that informal dealings, and relational contracts are important dimensions in contracting choices, especially in PPPs, in a world where it is impossible for contracting parties to anticipate contingencies that may arise throughout a contract's lifetime. Hence, these aspects should be accounted for when one ponders on the use of PPPs for the provision of public services.

Appendix A

Once the manager has reneged on his informal commitment, he is chosen at subsequent periods with a probability $p \in [0;1]$. This implies that at each period, his expected gain is pU_s^{NB} where s denotes the service $\mathscr{B}$ in case of unbundling, and denotes the services $\mathscr{A}$ and $\mathscr{B}$ in case of bundling. Let us note that such a probability is applied at each contract renewal, whether he has been chosen at previous period or not.

$U_{t,s}^{M,E}$ represents the expected payoff stream of the manager at period t, once he has cheated in period $(t-1)$. We may define $U_{t,s}^{M,E}$ as:

$$U_{t,s}^{M,E} = p[U_{t,s}^{M,NB} + \delta U_{t+1,s}^{M,E}] + (1-p)[0 + \delta U_{t+1,s}^{M,E}]$$

It then comes:

$$\begin{aligned} U_{t,s}^{M,E} &= pU_{t,s}^{M,NB} + \delta p U_{t+1,s}^{M,E} + (1-p)\delta U_{t+1,s}^{M,E} \\ &= pU_{t,s}^{M,NB} + p\delta U_{t+1,s}^{M,E} + \delta U_{t+1,s}^{M,E} - p\delta U_{t+1,s}^{M,E} \\ &= pU_{t,s}^{M,NB} + \delta U_{t+1,s}^{M,E} \end{aligned}$$

By recurrence,

$$\begin{aligned} U_{t,s}^{M,E} &= pU_{t,s}^{M,NB} + \delta[pU_{t+1,s}^{M,NB} + \delta U_{t+2,s}^{M,E} \\ &= pU_{t,s}^{M,NB} + p\delta U_{t+1,s}^{M,NB} + \delta^2 U_{t+2,s}^{M,E} \\ &= pU_{t,s}^{M,NB} + p\delta U_{t+1,s}^{M,NB} + p\delta^2 U_{t+2,s}^{M,NB} + \delta^3 U_{t+3,s}^{M,E} \end{aligned}$$

We deduce that: $U_{t,s}^{M,E} = \sum_{i=0}^{i=\infty} [\delta^i p U_{t+i,s}^{M,NB}]$

At each period i $U_{t+i,s}^{M,NB} = U_s^{M,NB}$, then $U_{t,s}^{M,E} = \sum_{i=0}^{i=\infty} [\delta^i p U_s^{M,NB}]$ and $U_{t,s}^{M,E} = \frac{pU_s^{M,NB}}{1-\delta}$

Therefore, if the manager cheats in period $t-1$, his expected gain is $U_s^{M,NB}$ in this period as he chooses the levels of investments that maximize his own present payoff, instead of first best level. For the next periods, he expects a discounted gain $U_{t,s}^{M,E}$. This can be write as follows: $U_s^{M,E} = [U_s^{M,NB}] + \delta U_{t,s}^{M,E} = U_s^{M,NB} + \frac{\delta p U_s^{M,NB}}{1-\delta}$

Appendix B

$T_{\mathscr{B}}$ is both upper and lower bounded. We have to show that the lower bound is always lower than the upper bound to prove the existence of $T_{\mathscr{B}}$.

From equation (2), we can deduce that

$$\delta U_{\mathscr{B}}^{PA,FB} - \delta p U_{\mathscr{B}}^{PA,NB} - \delta(1-p) U_{\mathscr{B}}^{PA,oo} \geq T_{\mathscr{B}} \tag{4}$$

And equation (3) provides a lower bound to $T_{\mathscr{B}}$:

$T_{\mathscr{B}} \geq \delta(p-1) U_{\mathscr{B}}^{M,NB} + U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}$

We now have to prove that $(4) > (3)$, i.e.:

$\delta U_{\mathscr{B}}^{PA,FB} - \delta p U_{\mathscr{B}}^{PA,NB} - \delta(1-p) U_{\mathscr{B}}^{PA,oo} \geq \delta(p-1) U_{\mathscr{B}}^{M,NB} + U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}$

$\delta U_{\mathscr{B}}^{PA,FB} - \delta p U_{\mathscr{B}}^{PA,NB} - \delta(1-p)(U_{\mathscr{B}}^{PA,00} - U_{\mathscr{B}}^{M,NB}) \geq U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}$

$\delta U_{\mathscr{B}}^{PA,FB} - \delta p U_{\mathscr{B}}^{PA,NB} + \delta(1-p) U_{\mathscr{B}}^{M,NB} + \delta(p-1) U_{\mathscr{B}}^{PA,00} \geq U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}$

$U_{\mathscr{B}}^{PA,FB} - p U_{\mathscr{B}}^{PA,NB} + (1-p) U_{\mathscr{B}}^{M,NB} + (p-1) U_{\mathscr{B}}^{PA,00} \geq \frac{1}{\delta}(U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB})$

$U_{\mathscr{B}}^{PA,FB} + (1-p) U_{\mathscr{B}}^{M,NB} + \frac{U_{\mathscr{B}}^{M,FB}}{\delta} \geq p U_{\mathscr{B}}^{PA,NB} + (1-p) U_{\mathscr{B}}^{PA,00} + \frac{1}{\delta} U_{\mathscr{B}}^{M,NB}$

$S^{FB} - U_{\mathscr{B}}^{M,FB} + (1-p) U_{\mathscr{B}}^{M,NB} + \frac{U_{\mathscr{B}}^{M,FB}}{\delta} \geq (1-p) U_{\mathscr{B}}^{PA,00} + \frac{1}{\delta} U_{\mathscr{B}}^{M,NB} + p(S^{NB} - U_{\mathscr{B}}^{M,NB})$

$S^{FB} + U_{\mathscr{B}}^{M,NB} + \frac{(1-\delta) U_{\mathscr{B}}^{M,FB}}{\delta} \geq (1-p) U_{\mathscr{B}}^{PA,00} + \frac{1}{\delta} U_{\mathscr{B}}^{M,NB} + p S^{NB}$

$S^{FB} - p S^{NB} + (1 - \frac{1}{\delta})(U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}) \geq (1-p) U_{\mathscr{B}}^{PA,00}$

$$S^{FB} - p S^{NB} - (1-p) U_{\mathscr{B}}^{PA,00} + (1 - \frac{1}{\delta})(U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}) \geq 0 \tag{5}$$

Recall that p denotes the probability for the private operator to be chosen again at the next contract renewal once he has deviated. As a consequence, $0 \leq p \leq 1$.

- If $p \to 0$, then the previous equation becomes

$$S^{FB} - U_{\mathscr{B}}^{PA,00} + (1 - \frac{1}{\delta})(U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}) \geq 0 \tag{6}$$

(6) is true because

$S^{FB} - U_{\mathscr{B}}^{PA,00} \geq 0$ as S^{FB} denotes the optimal surplus

$(1 - \frac{1}{\delta})(U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}) \geq 0$

- If $p \to 1$, then the previous equation becomes

$$S^{FB} - S^{NB} + (1 - \frac{1}{\delta})(U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}) \geq 0 \quad (7)$$

(7) is true because

$S^{FB} - S^{NB} \geq 0$ as S^{FB} denotes the optimal surplus

$(1 - \frac{1}{\delta})(U_{\mathscr{B}}^{M,NB} - U_{\mathscr{B}}^{M,FB}) \geq 0$

As a conclusion, whatever the value of p, (5) is true, which means that there is a positive interval in which $T_{\mathscr{B}}$ lies.

Notes

[1]Let us precise that the "bundling" of services mean here that the public authority decides to contract out several services to the same private operator rather than to choose a different operator for each service.

[2]Case studies undertaken by the World Bank [2006] (p.180) concerning Manilla and Gabon illustrate this point. The World Bank reports some informal commitments over additional investments by the concessionaires over the contract's lifetime. Some more general considerations are also given about the role of informal dealings at an early stage of cooperation between public and private partners. In the same way, Case 17 of the Resource Book on PPP Case Studies (European Commission [2004b]) accounts for the German experience (*Mülheimer Entsorgungsgesellschaft mbH*), and states that "to handle the complex multidimensional objectives and to protect their interests the parties had to agree on several informal and formalized agreements" (p.84).

[3]Contrary to some countries, as the United States, there is no contracting out towards public agencies. A municipality can either provide a service in-house, or choose to contract it out to a private operator.

[4] Communication OJ C 281, of 1996 (p.3), and OJ C 17 of 2001 (p.4) explained the interplay for the citizens' benefit between Community measures in the areas of competition and free circulation and public service tasks.

[5]More precisely, this mechanism of selection consists of a two-step procedure (Auby [1997]): First, the public authority chooses a certain number of potential candidates resorting to a classical competitive tendering process. Second, there is a phase of negotiation between the public authority and the potential entrants. At the end of the negotiation, the local public authority chooses its final partner for the duration of the contract. In other words, the municipality in France is not obliged to choose its partner by complying with objective criteria defined by law as this would be the case

in a strict competitive tendering process. It can select its partner more freely, using objective and also subjective criteria not necessarily specified by the law.

[6]Contrary to Hart et al. [1997], we will not consider the public provision case, to focus on the strategy of bundling when contracting out.

[7]We assume that innovations in cost reduction may have an adverse effect on quality. In other words, both cost and quality can reduced because of "e" innovations. As underlined by Hart et al. [1997] (p. 1128), critics of privatization often argue that " private contractors would cut quality in the process of cutting costs because contracts do not adequately guard against this possibility". For instance, private hospitals could reject expensive-to-treat patients, private schools could reduce their costs by hiring cheap teachers, which jeopardizes the quality of education, or private prisons could hire unqualified guards to save costs, thereby undermining safety and security of prisoners.

[8] As in HSV [1997], the public authority G does not maximize the global surplus during renegotiations: its utility function is given by the welfare of the rest of society, excluding the manager M. Indeed, "The political process aligns G's and society's interests (since M has negligible voting power, his interests receive negligible weight). As will become clear, if G placed the same weight on M's utility as on the rest of society, the first-best could be achieved".

[9]Indeed, as $b_{\mathscr{A}}(e_{\mathscr{A}}) = 0$ and $\beta_{\mathscr{A}}(i) = 0$, then $c'_{\mathscr{A}}(e_{\mathscr{A}}^{NB}) - b'_{\mathscr{A}}(e_{\mathscr{A}}^{NB}) \rightarrow c'_{\mathscr{A}}(e_{\mathscr{A}}^{NB})$. Therefore, incentives to reduce costs achieve the optimal level for service $\mathscr{A}$ under private provision.

[10] In a "bundling strategy", the operator M's utility function becomes $U_{\mathscr{A}+\mathscr{B}}^{M} = [P_{\mathscr{A}}^{0} - C_{\mathscr{A}}^{0} + c_{\mathscr{A}}(e_{\mathscr{A}}) - e_{\mathscr{A}}] + [P_{\mathscr{B}}^{0} - C_{\mathscr{B}}^{0} + \frac{1}{2}\beta_{\mathscr{B}}(i_{\mathscr{B}}) + c_{\mathscr{B}}(e_{\mathscr{B}}) - e_{\mathscr{B}} - i_{\mathscr{B}}]$, leading to the same incentives as in the case were services are not bundled, i.e. $c'_{\mathscr{A}}(e_{\mathscr{A}}^{NB,S}) = 1$, $c'_{\mathscr{B}}(e_{\mathscr{B}}^{NB,S}) = 1$, $\frac{1}{2}\beta'_{\mathscr{B}}(i_{\mathscr{B}}^{NB,S}) = 1$. Hence, we can see that investment incentives in this case is exactly the same as in the case where the public authority uses different operators for service $\mathscr{A}$ and service $\mathscr{B}$, *i.e.* $e_{\mathscr{A}}^{NB} = e_{\mathscr{A}}^{NB,S}$, $e_{\mathscr{B}}^{NB} = e_{\mathscr{B}}^{NB,S}$ and $i_{\mathscr{B}}^{NB} = i_{\mathscr{B}}^{NB,S}$

[11]Bull [1987] and Klein [1988] also suggest that reputation effects can limit holdup problems.

[12]By such a choice, we follow the literature on relational contracts, as developed by Baker et al. [1994, 2002, 2008]. We do not explore other alternative punishment strategies (such as tit-for-tat strategy for instance) to focus on the bundling question. The comparison of punishment strategies and the determination of the optimal punishment scheme (Abreu [1988]) will be investigated in further works.

[13]Such a transfer can correspond to a price increase during the contract execution.

[14]What happens in case of reneging is that the public authority is free to decide to stop the game with the private manager (and then turn to public provision or choose another private manager), or to continue the relationship, *i.e.* to select him again but without informal dealings, as the private manager is now considered as not trustworthy. For instance, we can suppose that the market is oligopolistic, and there is no other alternative than this private manager, or the costs to go back to the public provision are too high. To model such an alternative, there is a probability that affects reversion to Nash equilibrium of the static game as "punishment". Hence, the parameter $(1-p)$ allows us to capture outside options available to PA should he decide to change for another operator at the end of the contract. Let us add that in our incomplete contract framework, the threat of not being renewed for service A is a true damage for the manager, as this service generates an ex-post surplus because of the non-contractible innovations that happen during the execution of the contract.

[15]One could argue that the threat of the sanction is strong enough to dissuade the private operator from reneging.

This is true when $p \rightarrow 0$, i.e. the public authority can get rid of the private manager forever. But, when $p \rightarrow 1$, as discussed in the previous footnote, then the threat is not strong enough and a bonus is needed. Comparative statistics on results of the following subsection will show that $\frac{dT}{dp} > 0$, then the higher p is, the higher T has to be.

[16]Note that in this case, $U_{\mathscr{B}}^{M,R} = U_{\mathscr{B}}^{M,FB} + T_{\mathscr{B}}$, *i.e.* $U_{\mathscr{B}}^{M,R} = \delta(p-1)U_{\mathscr{B}}^{M,NB} + U_{\mathscr{B}}^{M,NB}$

[17] Indeed, we implicitly make the assumption that benefits from the optimal management of public services dedicated to public interest is sufficiently high that PA would have adequate incentives to respect her end of the dealing, *i.e.* to pay the minimum amount of bonus necessary to provide the private operator with incentives to undertake the investment efforts. This can be seen from the fact that the PA's outside option cannot enable her to achieve the first-best situation if she does not honor the informal contract. However, we are aware that this assumption may be too restrictive, and we intend to explore this issue in more details in the near future.

[18]Recall that for service $\mathscr{A}$, the Nash solution for the operator corresponds to the first-best, so there is no possible deviation.

[19]Let us precise that relational contracting between public and private partners is not exclusive to France, even if the selection procedure governing French public contracting provides a good case for such a study. Other examples of implicit dealings in public-private partnerships are suggested in many other reports, such as the Resource Book on PPP Case Studies (European Commission [2004b]), the Green Paper of European Commission [2004a] or the toolkit of the Worldbank World Bank [2006]. See footnote 2.

[20] All data comes from the IFEN and SCEES, with the exception of data concerning the type of treatment used for water before it is distributed, which comes from the DGS (Direction Générale de la Santé).

[21]Local authorities may choose different organizational choices for water production and distribution, so we restrict our sample to observations where water production and distribution are organized in the same way (*i.e.* through exactly the same type of contractual arrangement).

[22]There are three major operators in the French water industry and few other small ones specialized on some geographical areas. If we assume that each of the major players has a probability of 0.33 to be chosen for a service, the probability that the same operator is chosen for both services is $0.33 \times 0.33 \times 3 \approx 0.33$. Accounting for the existence of smaller players in local markets would bring this theoretical rate of observing an identical operator for both services to a lower level.

[23]We test the hypothesis according to which the difference in means is not significant, against the alternative hypothesis that prices are on the average lower when an identical operator is used. To implement these tests, we account for whether variance in the various samples could be considered as equal. The test statistics are respectively 1.18 (p-value 12%), 4.33 (p-value 0%), 3.86 (p-value 0.01%) and 4.89 (p-value 0%) for 1998, 2001, 2004 and the whole sample.

[24]For a more complete discussion on the impact of these variables on water prices, one may refer to Chong et al. [2006]

[25]Note that the French water industry is dominated by three operators, even if at the regional level, there may be some independent and small operators capable of running these services. This could cast some doubts on the level of competition in such markets.

[26]For instance, a report submitted to the UK water regulator, the OFWAT, shows some empirical evidence on this issue for the English and Welsh water industry Garcia et al. [2007]. Using data from the English and Welsh water

sector between 1992-93 and 2002-03, the report found no evidence of economies of scale nor economies of scope between drinking water services and sewage services. Using data from water utilities in Wiscousin, Garcia et al. [2007] found no evidence for economies of vertical integration even between production and distribution of drinking water. However, this latter study does not attempt to assess scale or scope economies for drinking water services and waste water services.

[27]This may be due to less haggling from both contracting parties.

[28]We are grateful to the referees for this suggestion.

[29]Basically, a decentralization law introduced in March 1982 granting municipality with greater autonomy in their policy. In 1993, the Sapin law (anti-corruption law) was introduced to make it compulsory for municipalities to organize a public tendering when they wish to delegate a public service. This latter also places a ceiling on the duration of contract (a maximum of 20 years for water services).

[30]The Hausman test leads us to conclude in favour of a fixed effect model (the test statistics is 2596.47, with a p-value of 0.000).

[31]There are only 3 periods in our sample.

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