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PUTTING ALL ONE'S EGGS IN ONE BASKET:
RELATIONAL CONTRACTS AND THE PROVISION OF
LOCAL PUBLIC SERVICES

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

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November 12, 2010

Abstract

The provision of local public services is increasingly being contracted out to private companies. We observe that local governments regularly choose the same private operator for a range of different services, and develop a model of relational contracts that shows how this strategy may lead to better performance at lower cost for public authorities. We test the implication of our model using an original database of the contractual choices made by 5000 French local public authorities in the years 1998, 2001 and 2004.

Keywords: bundling, contract, public-private partnerships, local public services

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1 Introduction

During the last few decades, the role of the private sector in the management of public services has been the subject of some debate, particularly within local government. In many countries, local public authorities such as municipalities must provide a wide range of services (e.g. street repair, water management, sewage treatment and disposal, urban transport). Recent data show the increasing involvement of the private sector in the management of these services. In the U.S.A. for example, around one third of residential solid waste collection, solid waste disposal and street repair services are provided through contracts with private firms (Levin and Tadelis (2008)). In Europe, the use of outsourcing has yielded even greater levels of success: 63% of medium-sized French cities contract out their water treatment and distribution functions, and 58% of them outsource their sewage treatment (Dexia Crédit Local de France (2006)).

Although the debate about the management of local public services focused first on the determinants of privatization (Williamson (1999); Hart et al. (1997); Lopez de Silanes et al. (1997)), there is now a fair degree of interest in some of the other issues involved. For example, some authors have compared the selection mechanisms (competitive bidding and negotiation) in order to determine their relative efficiency (Bajari et al. (2009)). Revenue sharing arrangements have also been studied (Engel et al. (2001, 2006)). The question of what determines the choice of private operators, however, has received rather less attention. Interestingly, local public authorities tend to contract out several different services to the same operator, even if they have access to a number of potential candidates (e.g. Gence-Creux, 2001). We herein consider the reasons why public authorities often choose to "bundle" their services in this way.¹ We herein show that bundling may represent a way of making contracts self-enforcing, thereby achieving a greater efficiency, i.e. an optimal level of cost-reducing investment at a lower price for consumers.

The perspective we adopt herein takes contractual incompleteness for granted. Indeed, the quality of services required by a public authority is often difficult or prohibitively costly to specify *ex ante*, at least in a way that can be enforced by a court of law (Hart et al. (1997)). As a consequence, renegotiation will occur *ex-post*. Yet, following the notion of "relational contracts" as defined by Baker et al. (2002) or Baker et al. (2008), tacit dealings between the parties concerned may create some incentives to invest in

¹The "bundling" of services described herein implies that the public authority decides to contract out several different services to the same private operator, rather than relying on a different operator for each service. Thus, "bundling" is always initiated by the public authority.

elements that are non-contractible. Because informal agreements cannot be enforced, self-enforcement arises as a result of the potential for future business between the partners, and with respect to reputational factors. The findings of Goldberg (1976), or recent reports such as that of the European Commission (2004b), underscore how informal relationships between public and private contractors may help to circumvent the difficulties found in formal contracting.²

We begin by developing a model in which a public authority decides to contract out the management of two services, whose non-contractible investments have different effects on the resulting social benefit. The public authority can decide to use a single private operator for both services, or to choose two different operators with two separate tenders. The key question we consider here is whether this decision affects the ways in which providers address non-contractible outcomes. We show that whether or not the transactions are bundled has no effect on efficiency in a static framework. However, where parties have concerns about future business opportunities, things are different. We demonstrate that a private partner may agree to invest at a level that is socially optimal provided that he is rewarded for such behavior by a bonus, or by a promise that he will subsequently be re-engaged. We show that for two different services, informal agreements are more easily sustainable when the private manager is awarded both contracts. This effect is similar to the effect of multimarket contacts as described by Bernheim and Whinston (1990) in their study of collusion. We extend the idea of multimarket contacts with different cost functions to a public-private relationship, and explore the consequences with regard to the performance of public services. More specifically, in our model, we show that the bonus that the public authority must pay to achieve the social optimum is lower when both contracts are awarded to the same operator, which implies that the total price paid for the management of both services is also lower.

We test the implications of our model using an original panel database containing data from the French Environment Institute (IFEN) and the French Health Ministry (DGS). The data consist of information related to 5000 local public authorities and their contracts in force in 1998, 2001 and 2004. The French case is particularly interesting, because municipalities have a legal obligation to provide some services but are free to choose how to do so. Many municipalities choose to contract out the provision of services, and allocate contracts through a franchise bidding process (Demsetz (1968)), an allocation mechanism

²Case studies undertaken by World Bank (2006) (p.180) in Manila and Gabon show the role of informal dealing in public-private partnerships. The World Bank reports some informal commitments to additional investment by the concessionaires over the lifetime of a contract. Case 17 in the Resource Book on PPP Case Studies (European Commission (2004b)) summarizes 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).

promoted through legislation at both national and European levels. In France, the selection of the private operator involves some negotiation, with room for informal agreements. For all these reasons, our data set provides us with a large, relevant and unique sample with which to assess our proposition.

Our results show that the use of the same operator for both the distribution and the sanitation of water leads to a significant price reduction for consumers. As a consequence, while previous works (Gence-Creux (2001)) have considered bundling as evidence of collusion or corruption, our results suggest that bundling may be a strategy for achieving better efficiency, and may benefit consumers.

The paper is organized as follows. In the next section, we describe the relevant literature and specify the contribution of our paper within it. In Section 3, we describe the institutional details of the management of local public services in France. We then present the model that yields our main propositions (Section 4). In Section 5, we present our data and tests. Our conclusions follow on from this.

2 Related literature

We believe that our paper makes an important contribution to the literature on relational contracting and on public-private partnerships. Our modeling approach is inspired by previous work on relational contracts as discussed by Baker et al. (1994, 2002, 2008). In particular, these authors show how objective and subjective performance measures may be optimally combined to ensure the provision of incentives. In our own paper, the combined use of formal and informal tools also helps to circumvent the difficulties experienced in contracting. However, our contribution departs from the approach of the authors cited above who considered the perspective of future transactions to be the main element in the enforcement of informal dealings. In contrast, we herein propose that the number of transactions that take place between identical partners also affects the enforcement of informal contracts. We further provide what we believe to be the first econometric test of this proposition using a database of public-private contracts. In a broader sense, organizational choices in the management of local public services were also studied by Levin and Tadelis (2008) and Lopez de Silanes et al. (1997). Both studies relied on U.S. data and focused on the determinants of privatization. Levin and Tadelis (2008) empirically observed, among other things, that a given service is more likely to be privately contracted if a city privatizes one other additional service. However, they provide no explanation of this phenomenon. Relying on the French

case alone, Gence-Creux (2001) theoretically explains the award of several contracts to the same private operator in terms of the electoral concerns of mayors. Using our theoretical and empirical results, we propose an alternative explanation for the case of benevolent governments. Other studies in the recent economic literature have explored related themes. In their study of collusion, Bernheim and Whinston (1990) examine the effect of multimarket contacts on the degree of cooperation that may be sustained by firms in settings where repeated competition occurs. Our methodological approach draws heavily on this work, but our results differ in that 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 provider has also been analyzed by Laux [2001] but in a different context. Using a principal-agent model, he shows how the bundling of projects can lead to the relaxation of the limited liability constraint by allowing punishments for projects that fail, instead of rewards reducing a manager's rent from each project. Our view is somewhat different here, because we emphasize the ways in which the bundling of projects can represent a rational strategy within an incomplete contract framework to help the enforcement of informal agreements in a public-private relationship. Finally, Yurukoglu (2008) shows how the bundling of television channels influences the bargaining outcomes achieved between distributors and channels, and increases social welfare. We share the view of this author that a bundling strategy may increase social welfare, however, his modeling approach differs from ours, because he relies on an industry model that is grounded by its institutional details and its historical data.

3 Institutional Details: Local public services in France

3.1 Contracting out of local public services

The 36,551 municipalities in France are legally responsible for the satisfactory operation of many different public services (such as urban transport, the distribution of drinking water, sewage treatment, the collection and processing of household waste, social actions and cultural activities). National legislation requires that adequate (both in terms of quantity and quality) services be supplied to every potential user in the local community. Municipalities may decide to operate these services themselves (possibly in

association with other local communities), or to contract them out to a private firm.³ Contracting out is a common strategy⁴ for the management of operational tasks, or to encourage investment in the public service.

The relationship between a municipality and a private operator is governed by contracts, for which there is no central regulatory body.⁵ Among other things, the contract formalizes the result of the negotiations on price. Only the environmental aspects, and the standards of quality of the services concerned are controlled by local and national environmental agencies. Therefore, as underlined by Nauges and Thomas (2000), the French system for the organization of water supply is different from that found in England and Wales (where an independent agency, OFWAT, regulates the regional companies that own the municipal water infrastructure and implements a price-cap policy), or in the U.S.A. (where private utilities are subject to public regulation, in order to ensure that rates are fair, given a reasonable efficiency of the system). **Consequently, in France, significant differences in price may be observed between one city and another.**

Surprisingly enough, when contracting out, municipalities (at least in France) appear regularly to choose the same private firm to manage different services. The following graph from Gence-Creux (2001) shows the percentage of municipalities in 2001 that chose the same private operator to manage different pairs of services. For example, more than 50% of the municipalities that contracted out both their water and garbage services chose the same private operator. We note that nationally, three large companies share the market for public services, but some other (smaller) providers appear at the local level. Although only a few firms operate in the market for public services, the observed concentration is above the theoretical level that may be expected. Such a theoretical level is derived under the assumption that each firm that is willing to enter the market has an equal probability of winning the contract.⁶

³In contrast to the U.S.A., there is no contracting out to public agencies. The municipality either provides the service itself or contracts it out to a private firm. Different contractual agreements exist that give more or fewer responsibilities to the private partner. We describe these contractual arrangements in the empirical section.

⁴As stated in the introduction, a recent official report (Dexia Crédit Local de France (2006)) states that 63% of French medium-sized cities contract out the services of potable water treatment and distribution, 58 % also contract out their sewage treatment, and 69 % use private operators for urban transport.

⁵Conflicts are resolved through the relevant legal system. However, it must be noted that very few cases are ever brought before the courts. Many potential conflicts are solved by the parties themselves.

⁶For example, assuming that there are 3 firms in the market that are each capable of providing two services, each of them has a probability of 1/3 of being chosen for each service. The theoretical probability that a firm operates both services is therefore 1/9, and the theoretical bundling level is 1/3 (because there are 3 firms and each has a probability of 1/9 of being awarded both services). See Gence-Creux (2001).

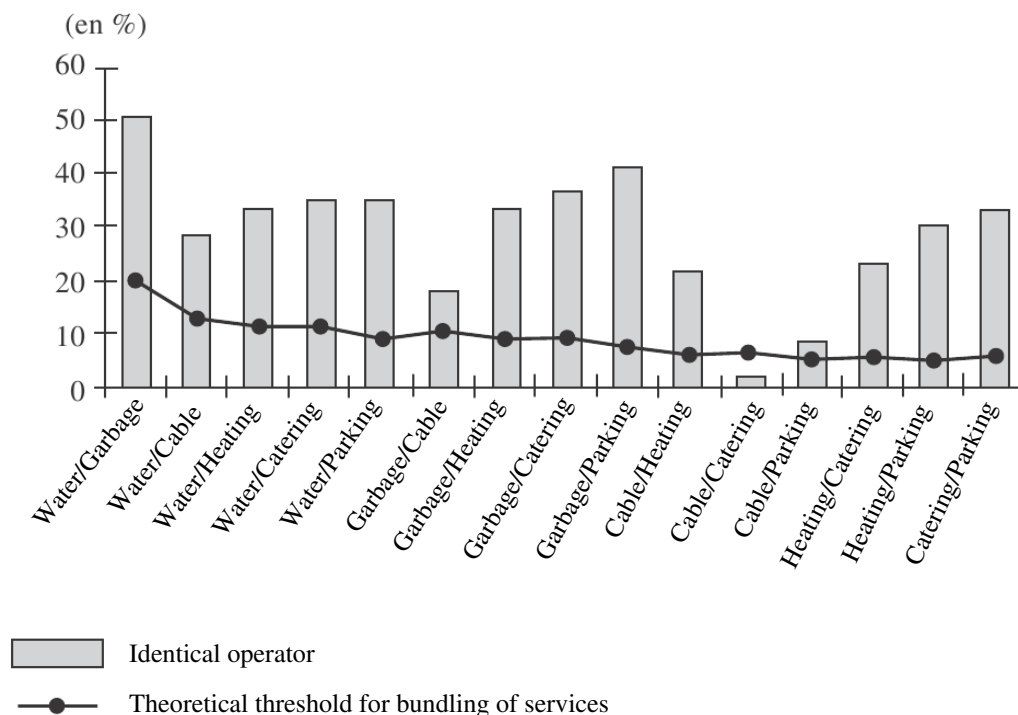


Figure 1: Allocation of services to the same operator (Gence-Creux [2001])

Figure 1 illustrates the "bundling strategy" of the municipalities, i.e. the choice of the same private partner for different services. We now give some details of the selection mechanism used for private operators.

3.2 Legal procedures to select private operators

In France, whenever a municipality decides to make use of a private firm to manage a public service, the service is put to tender. The successful private company benefits from a local monopoly for the duration of the contract (12 years on average), after which time the market is reopened to competition. The selection mechanism is different from that seen in many other countries, where the winner is the candidate with the lowest bid, provided that some objective criteria are met (Auby (1997)). The selection mechanism in France consists of a two-step procedure:

- In the first step, the public authority chooses a certain number of potential candidates by using a classical competitive tendering process.
- In the second step, there is a phase of negotiation between the public authority and the potential operators. At the end of the negotiation, the public authority chooses its partner for the duration of the contract.

What is important here is that the municipality is not obliged to choose its partner strictly in terms of objective criteria defined by law, as would be the case in a strict competitive tendering process. This two-step procedure affords a greater degree of freedom to the public authority. It can select its partner more freely, using both objective and subjective criteria (the latter during the negotiation stage), even if they are not necessarily specified in law. Contracts are said to be concluded *intuitu personae*, which allows room for informal discussions. This is a distinctive characteristic of all contracts that involve public partners.⁷ For all these reasons, we contend that public contracts in France have a relational dimension, and can provide data with which to test propositions about informal practices.

3.3 The costs and prices of services

When a private company is chosen to manage a public utility, the private firm and the municipality decide on a price by mutual consent (Nauges and Thomas (2000)). The price of the utility is negotiated between the municipality (representing the citizens) and the private operator, and is paid by the users. As a consequence, the price paid for water services is generally the subject of some debate, and is one of the recurrent political criteria by which the performance of a town council may be assessed. Associations of consumers regularly publish articles about the price paid in each municipality (Union Fédérale des Consommateurs (2006)).

During the negotiation, the whole rate structure is determined, i.e. both the type of tariff (linear, two-part, increasing or decreasing blocks), and the water price charged by unit consumed for each class of user (farmers, industrial or domestic users). The municipality and the private operator agree on three different elements: a basic tariff, a formula for annual price revision, and clauses that allow for exceptional conditions.

⁷Article L 1411-1 of *Code Général des Collectivités Locales*.

The basic tariff and the formula for price revision are determined, *a priori*, for the duration of the contract. A formula for annual price revision is necessary because the private operator bears a set of operating costs that are affected by variations in input prices and productivity earnings. Furthermore, exogenous shocks on demand may affect the operating conditions. Consequently, the legislation now includes the possibility of updating the contract terms where appropriate. In any case, the price revision results from the bargaining that takes place between the parties. The negotiated price must therefore account for both the management constraints faced by the private operator, and the orientation of the local tariff policy as defined by the objectives of the municipality concerned.

4 The model

In this section, we present a simple model to show how the use of a bundling strategy may affect the performance of a private operator in the management of local public services.

4.1 The general framework

Following Hart et al. (1997)⁸, we assume that a benevolent public authority (to whom we refer as “she”) is responsible for providing two public services to users. We denote these services as \mathcal{A} and \mathcal{B} . In order to provide these two services, we assume that the public authority must rely on external managers who operate under a contract.

We assume that the contracts are incomplete, as defined by Grossman and Hart (1986), Hart and Moore (1990) or Hart (1995). Therefore, in the execution of a contract, the private operator of a service may come up with new and innovative ways to reduce the costs of provision of the services concerned. Such innovative efforts are *uncontractible ex ante*, but *observable ex-post (and verifiable)*, provided that the relevant contingencies have been realized.

⁸We use the general framework of Hart et al. (1997) but diverge from it in two respects: firstly, we will not consider public provision, in order to focus on the strategy of bundling when contracting out. Secondly, we focus on only one type of uncontractible investment, namely the opportunity for cost-reducing innovation, because such investments raise issues in the case of privatization, while incentives to innovate in terms of quality are closer to their optimal level under private provision than they are under public provision.

4.1.1 Production technologies

We herein assume that, *ex ante*, for each service, the cost of provision incurred by an operator is C_s^0 , $s \in \{\mathcal{A}, \mathcal{B}\}$. For simplicity, this cost is assumed to be the same for all operators, and known to all. In the same way, we denote the benefits to society from the provision of the service s as B_s^0 , $s \in \{\mathcal{A}, \mathcal{B}\}$. Following Hart et al. (1997), we call this service the "basic" service, and denote its price P_s^0 . This price reflects the *ex ante* bargaining powers of the parties concerned.⁹

Operators may undertake some uncontractible efforts in order to reduce the costs of the service they provide. The cost-reducing innovations for a given service s are denoted e_s , $s \in \{\mathcal{A}, \mathcal{B}\}$. After the implementation of these innovations, the costs of providing a service s are

$$C_s = C_s^0 - c_s(e_s) + e_s$$

where $c_s(e_s) \geq 0$ is the reduction in costs that corresponds to the innovation e_s for the service s .¹⁰ However, the function of the social benefits is different for service \mathcal{A} and service \mathcal{B} . This assumption illustrates the varying effects that the cost-reducing opportunities have on the different services. More precisely, service \mathcal{A} is a "simple" service, because its social benefits are contractible, so that $B_{\mathcal{A}} = B_{\mathcal{A}}^0$. In other words, cost reductions do not have any effect on the quality of the service provided.

In contrast, the social benefits of providing service \mathcal{B} are given by the equation $B_{\mathcal{B}} = B_{\mathcal{B}}^0 - b_{\mathcal{B}}(e_{\mathcal{B}})$, where $B_{\mathcal{B}}^0$ represents the contractible level of quality, and $b_{\mathcal{B}}(e_{\mathcal{B}}) \geq 0$ is the reduction in quality created by the cost-reducing innovations for service \mathcal{B} .¹¹ Indeed, we assume that innovations in cost reduction may have an adverse effect on quality. In other words, both cost and quality can be reduced because of the opportunities for innovations denoted by "e." This corresponds to the classic case of Hart et al. (1997), which accounts for those critics of privatization who often argue that "private contractors would cut quality in the process of cutting costs because contracts do not adequately guard against this possibility" (Hart et al. (1997), p. 1128). These fears are particularly relevant in the case of environmental services such as water supply or sanitation because they are closely related to public health. Furthermore, private

⁹As described in the institutional details, the price is negotiated between the firm and the private company. Each service is intended to generate a surplus for the operator.

¹⁰We make the following assumptions: $c_s(0) = 0$, $c'_s(0) = \infty$, $c'_s(e_s) > 0$, $c''_s(e_s) < 0$, $c'_s(\infty) = 0$.

¹¹We make the following standard assumptions: $b_{\mathcal{B}}(0) = 0$, $b'_{\mathcal{B}}(e_{\mathcal{B}}) \geq 0$, $b''_{\mathcal{B}}(e_{\mathcal{B}}) \leq 0$; $c'_{\mathcal{B}}(e_{\mathcal{B}}) - b'_{\mathcal{B}}(e_{\mathcal{B}}) \geq 0$. The assumptions $c'_{\mathcal{B}}(e_{\mathcal{B}}) - b'_{\mathcal{B}}(e_{\mathcal{B}}) \geq 0$ imply that the quality reduction from a cost innovation for service \mathcal{B} does not offset the quality increase.

companies may harness the power of innovations to improve their results. A recent report published by one of these companies states that "Research is a priority (...) Our mission is to take up the environmental industrial challenge by devising disruptive technological solutions and applying them on an international scale. We create new models based on an anticipation of tomorrow's requirements rather than waiting for a problem to emerge before taking action (...) Our research is targeted at (...) optimizing operational cost".¹²

As is standard practice in the literature on incomplete contracts, we assume that c_s , $b_{\mathcal{B}}$, and $e_{\mathcal{B}}$ are observable to the contracting parties, but not verifiable to outsiders (e.g. the courts).

We further assume that the public authority is benevolent, and so makes the decisions to maximize the surplus enjoyed by consumers.¹³ Furthermore, parties may solve the problem of contractual incompleteness by leveraging the value of future relationships. This means that relational contracts (Bull (1987); Baker et al. (2002); MacLeod (2007)) can be implemented. In our model, the aim of informal contracts is to motivate the operator to achieve the first-best level of investments e^{FB} , in exchange for a supplementary monetary transfer from the public authority to the operator. This transfer can take the form of a higher *ex ante* price, as agreed when the contract is signed at $T=0$. The timing of the one-shot static game is depicted in Figure 2.

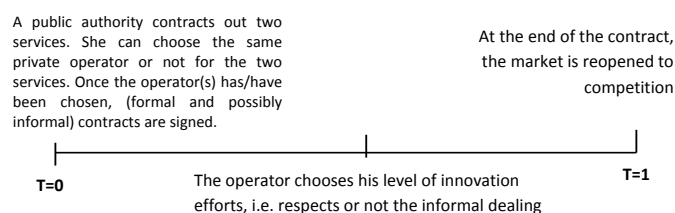


Figure 2: Timing of the game

Under this framework, the public authority is confronted with the decision of whether to use the same private operator for the provision of both services, or to contract out the provision of each service to a

¹² Report "Research and Development 2008", Veolia Environment.

¹³ As in HSV [1997], the public authority G does not maximize the global surplus during renegotiations; its utility function is reflected in 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".

different operator (i.e. the unbundling strategy).

4.2 The first-best

We briefly derive the first-best case as a benchmark. In this situation, we assume contractual completeness and first-best incentives for service s are those that maximize:

$$\max_{e_s} [B_s^0 - C_s^0 - b_s(e_s) + c_s(e_s) - e_s]$$

where $s \in \{\mathcal{A}, \mathcal{B}\}$ and $b_{\mathcal{A}}(e_{\mathcal{A}}) = 0$. Therefore, the first-best level of the efforts made for cost-reducing innovations for service \mathcal{B} are characterized by $c'_{\mathcal{B}}(e_{\mathcal{B}}^{FB}) - b'_{\mathcal{B}}(e_{\mathcal{B}}^{FB}) = 1$. For service \mathcal{A} , they are given by $c'_{\mathcal{A}}(e_{\mathcal{A}}^{FB}) = 1$, because $b_{\mathcal{A}}(e_{\mathcal{A}}) = 0$.

4.3 The one-shot game

As demonstrated by Hart et al. (1997), private provision leads to the following payoffs:

for the public authority: $U_s^G = B_s^0 - P_s^0 - b_s(e_s)$

and for the private operator: $U_s^{Ms} = P_s^0 - C_s^0 + c_s(e_s) - e_s$

In maximizing his payoff, the private operator of service s chooses e_s^{NB} such that $c'_s(e_s^{NB}) = 1$.

The efforts devoted to the achievement of cost-reducing innovations are optimal. However, for service \mathcal{B} , contractual incompleteness leads to his making an excessive amount of effort to reduce costs.¹⁴

The granting of both contracts to the same operator in this case has no effect on the outcomes concerned.¹⁵ This is obvious, given our assumption that the services are in no way related. All this is summarized in the following proposition:

¹⁴This is because the private operator does not sufficiently internalize the negative effects of cost-reducing innovations for society as a whole, and because his incentives for quality-enhancing innovations are dampened by the fact that he only receives half the benefits of those innovations at the margin.

¹⁵In a "bundling strategy", the operator M's utility function becomes $U_{\mathcal{A}+\mathcal{B}}^M = [P_{\mathcal{A}}^0 - C_{\mathcal{A}}^0 + c_{\mathcal{A}}(e_{\mathcal{A}}) - e_{\mathcal{A}}] + [P_{\mathcal{B}}^0 - C_{\mathcal{B}}^0 + c_{\mathcal{B}}(e_{\mathcal{B}}) - e_{\mathcal{B}}]$, leading to the same incentives as in the case where the services are not bundled, i.e. $c'_{\mathcal{A}}(e_{\mathcal{A}}^{NB,S}) = 1$, $c'_{\mathcal{B}}(e_{\mathcal{B}}^{NB,S}) = 1$.

Proposition 1 *In the static game, with two services, one with and one without adverse effects on quality when costs are reduced, it is irrelevant whether a public authority considers awarding the contracts to the same operator or to different ones.*

4.4 The repeated game framework and relational contracting

In this subsection, we follow the standard mechanism described in the literature of informal and relational contracting (Bull (1987); Baker et al. (1994, 2002); Klein (1988, 1996)). These authors either show how the occurrence of repeated interaction between partners helps to achieve first-best outcomes that are not otherwise achievable through formal contracts, or suggest that reputational effects can limit hold-up problems. Using repeated games, we show why the value of future business should lower the over-optimal incentive of the private operator to invest in cost reduction. Furthermore, as in Bernheim and Whinston (1990), we emphasize how multimarket contacts facilitate this mechanism.

More precisely, we assume that the public authority can offer an informal contract to the private operator that specifies the first-best level of effort $e_{\mathcal{B}}^{FB}$.

Let us denote $U_{\mathcal{B}}^{M,FB}$ (resp. $U_{\mathcal{B}}^{G,FB}$) as the payoffs of the operator of service \mathcal{B} (resp. of the public authority) when first-best investments are made during the management of service \mathcal{B} . To compensate for the decrease in the profits of the private operator, the public authority promises him a transfer T that takes the form of a higher *ex ante* price. As described in subsection 3.3, this price is determined by the parties when the contract is signed at $T=0$. At this time, the public authority can propose an informal deal, in that she accepts a higher price and in exchange asks the private manager for first-best levels of investment.¹⁶

The final payoffs of each party are then:

$$\begin{aligned} U_{\mathcal{B}}^{M,R} &= U_{\mathcal{B}}^{M,FB} + T \\ U_{\mathcal{B}}^{G,R} &= U_{\mathcal{B}}^{G,FB} - T \end{aligned}$$

A period in our framework is the contract duration. Thus, in each period, the public authority can choose either to continue the relationship or to end it. Then, if the private operator does not respect the informal

¹⁶As a consequence, the total *ex ante* price in case of relational contracting is P_s^0 and the bonus T .

deal, the public authority threatens him with a lower probability of renewal.¹⁷ This implies that the public authority will reselect him for subsequent periods with a probability $0 \leq p \leq 1$, and will refuse to do so with a probability $(1 - p)$. We assume that the public authority cannot threaten to eliminate the operator altogether, because in some cases, there is no alternative to this private manager (i.e. there is no other candidate), or the costs of resorting to public provision are too high. For simplicity, we assume that p does not change over time. The probability $(1 - p)$ allows us to account for the outside options available to the public authority should he decide to change to another operator at the end of the contract.¹⁸ Because the public authority is not always able to eliminate the manager from future negotiations in the case of deviation, the threat of punishment may be insufficient to provide incentives for him to cooperate. For this reason, the public authority also proposes an award (the bonus T) in the case of cooperation. As a consequence, both the perspective of future business and the promised monetary award are intended to provide the appropriate incentives.

It should be noted that the only relevant information about the previous period is whether or not there has been any deviation. The discount factor is $0 \leq \delta \leq 1$. It then remains to be determined what kind of transfer T (i.e. sharing of the surplus) allows the relational contract to be self-enforcing. To model the relational contract, we use a trigger strategy.

We will show that when two contracts - one with and one without adverse effects - are signed by the same partners, the level of transfer ($T_{\mathcal{A}+\mathcal{B}}$) is lower than the level ($T_{\mathcal{B}}$) when only one contract is contracted out. As a consequence, under relational contracting, the total price paid by the public authority for the services is lower in the case of bundling than in the case of non-bundling.

¹⁷ We assume that benefits that accrue from the optimal management of public services that are dedicated to the public interest are sufficiently high that the public authority would have adequate incentives to respect her end of the deal, i.e. to pay the minimum amount of bonus necessary to provide the private operator with incentives to undertake his investment efforts. This can be seen in view of the fact that the public authority's alternative option would not enable her to achieve the first-best outcome if she does not honor the informal contract. For this reason, we only explore the conditions under which the manager respects his informal promise (and not those of the public authority). However, we are aware that this assumption may be too restrictive, and we intend to explore this issue in greater detail in the near future.

¹⁸ In our incomplete contract framework, the threat of not being renewed for service A causes real damage to the manager, since this service generates an *ex post* surplus because of the non-contractible innovations that occur during the execution of the contract, and because of the negotiated price (as described in the institutional details).

4.4.1 The “unbundling” strategy: A different operator for each service

We now suppose that the public authority has chosen a different operator for each service.

For service \mathcal{A} , there is no need to implement any relational agreement to achieve the first-best, because the 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 $P_{\mathcal{A}}^0$, as described above.

For service \mathcal{B} , first-best levels of incentives are achieved only if the relational contract described above is implemented. Let us denote as $T_{\mathcal{B}}$ the transfer of the public authority to the private manager in this case. We want to determine the level of such a transfer that is required for the relational contract to become self-enforcing.¹⁹ In other words, we determine the level of transfer so that the discounted payoff stream of the private manager is higher under cooperation than it is under deviation path²⁰:

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

The private manager gains $U_{\mathcal{B}}^{M,NB} + T_{\mathcal{B}}$ when he deviates, because he still benefits from the transfer despite his deviation, but he is punished in the next turns and receives $\frac{\delta p U_{\mathcal{B}}^{M,NB}}{1 - \delta}$ (See Appendix A for derivation). This allows us to show that $T_{\mathcal{B}}$ is bounded:

$$T_{\mathcal{B}} \geq (p - 1)U_{\mathcal{B}}^{M,NB} + \frac{U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB}}{\delta} \quad (2)$$

When this condition is satisfied, the relational contract is self-enforcing for the private manager.²¹ Note that the lower the transfer is, the lower the temptation to deviate for the party that provides the transfer. Furthermore, since the public authority only cares about the surplus of the consumers, she wishes to pay

¹⁹One could argue that the threat of the sanction (i.e. of non-renewal) is sufficiently strong to dissuade the private operator from renegeing on the contract. This is true when $p \rightarrow 0$, i.e. the public authority can be 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 statistical analysis of the results in the following subsection will show that $\frac{dT}{dp} > 0$.

²⁰We consider no outside option for the private manager if his contract is not renewed. It is difficult to assess whether other municipalities will trust him or not, because communication between public authorities is imperfect. Nevertheless, it is hard to determine precisely how “imperfect” it is. For simplicity, we then model a bilateral relationship, and assume no outside option for the manager concerned.

²¹Note that in this case, $U_{\mathcal{B}}^{M,R} = U_{\mathcal{B}}^{M,FB} + T_{\mathcal{B}}$, i.e. $U_{\mathcal{B}}^{M,R} = \delta(p - 1)U_{\mathcal{B}}^{M,NB} + U_{\mathcal{B}}^{M,NB}$

the lowest possible transfer. Therefore, in equilibrium, $T_{\mathcal{B}}^*$ is such as (2) is just satisfied, *i.e.*

$$T_{\mathcal{B}}^* = (p - 1)U_{\mathcal{B}}^{M,NB} + \frac{U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB}}{\delta}.$$

The total cost for the public authority to provide both services is then $P_{\mathcal{A}}^0$ for the service \mathcal{A} , and $P_{\mathcal{B}}^0 + T_{\mathcal{B}}^*$, *i.e.* the *ex ante* price $P_{\mathcal{B}}^0$ and the *ex post* transfer, for service \mathcal{B} . Denoting P^U as the total cost for both services, we have $P^U = P_{\mathcal{A}}^0 + P_{\mathcal{B}}^0 + T_{\mathcal{B}}^*$.

4.4.2 The “bundling” strategy: using the same private operator

Let us now suppose that the two services are bundled, *i.e.* the same private operator manages both services. We wish to determine the transfer payment $T_{\mathcal{A}+\mathcal{B}}$ that makes the relational contract self-enforcing. As in the previous case, the private manager either accepts the transfer $T_{\mathcal{A}+\mathcal{B}}$ (through a price increase), or deviates and prefers to maximize his own profits. As a consequence, the public authority will select him again for each service with a probability $0 \leq p \leq 1$. However, contrary to the case of unbundling, punishment here is applied to both contracts, *i.e.* for services \mathcal{A} and \mathcal{B} . As stated in Bernheim and Whinston (1990), multi-market contacts increase the level of punishment in the case of deviation.

As a consequence, when the informal deal is respected, the private manager’s payoff is: $U_{\mathcal{A}+\mathcal{B}}^{M,R} = U_{\mathcal{A}}^{M,NB} + U_{\mathcal{B}}^{M,FB} + T_{\mathcal{A}+\mathcal{B}}$.

In the case of deviation, he gains on the contract for service \mathcal{B} , *i.e.* $U_{\mathcal{B}}^{M,NB}$, but is selected again for the other periods with a probability p , for both contracts.²² As a result, the private manager honors his informal agreement when:

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

In the same way as for our previous discussion, the public authority will select the lowest possible amount

²²Recall that for service \mathcal{A} , the Nash solution for the operator corresponds to the first-best, so there is no possible deviation.

of transfer to maximize consumers' surplus, so that

$$T_{\mathcal{A}+\mathcal{B}}^* = (U_{\mathcal{A}}^{M,NB} + U_{\mathcal{B}}^{M,NB})\delta(p-1) + (U_{\mathcal{B}}^{M,NB} - UM_{\mathcal{B}}^{M,FB})$$

The total cost to the public authority is therefore $P^I = P_{\mathcal{A}}^0 + P_{\mathcal{B}}^0 + T_{\mathcal{A}+\mathcal{B}}^*$.

4.4.3 Cost comparison and proposition

Let us now compare the total cost in each case, i.e. P^I and P^U .

- In the case of unbundling, $P^U = P_{\mathcal{A}}^0 + P_{\mathcal{B}}^0 + T_{\mathcal{B}}^*$

$$P^U = P_{\mathcal{A}}^0 + P_{\mathcal{B}}^0 + (p-1)U_{\mathcal{B}}^{M,NB} + \frac{U_{\mathcal{B}}^{M,NB} - UM_{\mathcal{B}}^{M,FB}}{\delta}$$
- In the case of bundling, $P^I = P_{\mathcal{A}}^0 + P_{\mathcal{B}}^0 + T_{\mathcal{A}+\mathcal{B}}^*$

$$P^I = P_{\mathcal{A}}^0 + P_{\mathcal{B}}^0 + (p-1)(U_{\mathcal{A}}^{M,NB} + U_{\mathcal{B}}^{M,NB}) + \frac{(U_{\mathcal{B}}^{M,NB} - UM_{\mathcal{B}}^{M,FB})}{\delta}$$

Since $(U_{\mathcal{A}}^{M,NB} + U_{\mathcal{B}}^{M,NB})(p-1) \leq (p-1)U_{\mathcal{B}}^{M,NB}$, then $P^I \leq P^D$.

Proposition 2 *When two services, one with and one without the adverse effects described above, are managed by a single operator, the public authority can pay a lower total price and still obtain the same levels of service and investment compared to those obtained when the two services are contracted out to different private firms.*

5 Empirical analysis

5.1 Putting the model to the test

Our model focuses on two types of service, one with and one without adverse effects on quality as a result of cost reductions. It shows that bundling, i.e the provision of two services by the same private operator, facilitates the enforcement of relational contracts.

In order to test our theory, we must find at least one service whose uncontractible cost-reducing investments do not affect the quality or the utility of the government (service \mathcal{A} in our model). This represents a significant empirical challenge, because it implies some "limited" contractual incompleteness, *i.e.* a service for which cost-reducing investments cannot be contracted *ex ante*, but in which quality is never damaged by them. Nevertheless, it is easy to see that our results could be extended to the case of two services, one whose uncontractible cost reductions are likely to result in strong adverse effects on the quality of the service concerned, and another for which the cost reductions are likely to generate only weak adverse effects. A comparison of our theoretical findings to empirical data therefore requires us to identify two services - one characterized by *high* and the other by *low* adverse effects on quality following the imposition of uncontractible cost reductions. Our model then suggests that the prices paid by the public authority are likely to be lower in the case of bundling than in the case of unbundling.

The French water sector appears to provide a particularly interesting testing ground for our propositions, by virtue of the fact that there are two types of water service that a municipality must provide to consumers, namely drinking water and waste water (or sanitation). Those two services are clearly separated and give rise to two different contracts that may apply with or without the same operator. The provision of the former service involves the production and distribution of drinking water to the population, while the latter involves the collection and treatment of foul water. We further observe that in general, firms that can provide one of these services can also provide the other.

In addition, it may be seen that quality is a more sensitive issue in relation to drinking water than in relation to waste water. Hazards to public health exist in both cases, but because of the public safety concerns related to drinking water, consumers are better able to assess quality in this service than they are in sanitation. As a consequence, municipalities may be rather more concerned with providing adequate incentives to ensure the quality of drinking water than they are of the quality of treatment of waste water, especially in terms of their willingness to respond to complaints in order to achieve subsequent electoral success.²³ The differences between the two services may also be highlighted by the numbers of water quality standards that govern the qualities of drinking water and waste water. 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 about 53 water quality standards to which drinking water must

²³The European Commission brought France to trial in front of the European Court of Justice in November 2009 as a result of failures in water treatment by a number of local authorities. This suggests that the service is not taken sufficiently seriously by some public authorities (Le Monde newspaper - November 20th, 2009)

comply. In contrast, 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 suggests that the control of quality in drinking water can be more costly and more complicated than it is in waste water.

The French case is also of interest here because of the principle of *intuitu personae* that regulates the contracts between public and private partners (hereafter called "public-private partnerships"). A municipality that puts a service out to tender is not legally obliged to publish any objective or subjective criteria for selecting the winning tender (Auby (1997)). Public authorities also are permitted to negotiate with bidders before choosing the final partner. Such freedom for public authorities introduces subjective elements during the decision-making process, and allows the customization of the relationships that exist between public and private partners. This leaves room for informal dealings between contractors. This may also leave room for corruption, as previously explored in research on public procurement (Compte et al. (2005); Maskin and Tirole (2007)). Our model shows how this informal dimension can also open the door to potential relational agreements that can yield better incentives for investment.²⁴

5.2 Linking the model with the data

In order to test our proposition, we have developed a unique panel dataset by combining data from the French Environment Institute (IFEN) and the French Health Ministry (DGS), relating to 4987 local public authorities in 1998, 2001 and 2004, yielding a sample of 14,961 water services. This sample is representative of the total population of French local public authorities, in that all local authorities with more than 10,000 inhabitants are included in the sample, while those with less than 10,000 inhabitants are represented proportionally. By eliminating observations that have missing data and focusing only on those municipalities whose services are managed through public-private partnerships, our sample is reduced to 7002 observations over the three years. Each observation is characterized by a contractual choice made by a municipality at time t .

Our theoretical model suggests that bundling services together may help to sustain relational contracts

²⁴Relational contracting between public and private partners is not exclusive to France, even if the selection procedure that governs French public contracts provides good material 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).

between agents and, as such, can lead to improvements in welfare. The main implication of our theoretical analysis for the water industry is that prices for drinking water should be lower when the same operator is used for waste water, i.e. when drinking water services (distribution contract) and sanitation services (waste water contract) are provided by the same operator. Indeed, the model suggests that bundling services together will affect prices because the contemporary negotiation of both services (i.e. if the date of signature on both contracts is the same) allows the local authority to negotiate a price that is lower than for the case of unbundling in order to force the private operator to cooperate. The model suggests that this effect might also occur when the water distribution contract is signed *after* the waste water contract, but not *vice versa*, of course.²⁵ In order to investigate the effect of bundling on prices, we created two variables, *Bundle1* and *Bundle2*. The first restricts the bundling effect to the case where the contracts are signed simultaneously for both services. The second also considers bundling when contracts are signed not simultaneously, but when the distribution contract is signed after the waste water contract. Because the price obtained by operators during the negotiation with local authorities is paid totally and directly by consumers, we will focus here on consumers' water bills in order to measure the effect of bundling.

Simple comparisons of average prices suggest that such an effect exists (See Appendix 3). 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 affect prices and their evolution (*e.g.* characteristics of the networks, size of the population, etc.). Therefore, in order to test the implications of our model, we need to estimate the effect on price when services are bundled *ceteris paribus*. A simple method of doing this is to estimate the impact of bundling on the prices paid by consumers for their drinking water services whilst controlling for heterogeneity between different water services. A negative estimated effect of bundling on the water prices paid by consumers would be consistent with the prediction made in our theory. In addition to the contractual choices made by French municipalities, our data include information on the respective networks involved, which will help us to deal with any heterogeneities involved, i.e. the density of the network, the origin of the water, the kind of treatment required to purify the water prior to distribution, the size of the population affected by the contract, and other aspects that

²⁵The transfer that is negotiated by the local authority with the private operator is translated into price provisions negotiated in the contract. The model suggests that the bundling effect should only be significant with negotiated water distribution prices. If water distribution prices have been already negotiated without any bundling, giving the same operator the contract for waste water services afterwards can only affect the distribution prices when the contract is renewed.

could affect water prices. Our variables are described in Table 1.

However, our empirical strategy must also account for two further issues: firstly, a lower price paid by consumers when drinking water and sanitation services are bundled may also reflect the potential synergies that exist between the two types of service. Secondly, municipalities may endogenously decide to bundle drinking water and sanitation services, in anticipation of the likely gains for consumers. A failure to account for the heterogeneity among municipalities that could lead to such decisions could lead to inconsistent estimates. In the following section, we shall discuss both these issues and present our econometric specification to address these issues within our estimation strategy as a whole.

5.2.1 Synergy issues

The existence of economies of scale and/or scope between drinking water and sanitation services can provide an alternative explanation for the lower price paid by consumers for their drinking water when a single operator provides both services. Without addressing this issue, we cannot know from our estimates the extent to which the effect of contract bundling may be due to the relational contract or to the synergies that exist between the two services. This is the nature of the challenge that we should address in our empirical work, even though previous empirical studies appear to have found little evidence of synergies between these two types of activity.²⁶ In the following section, we shall discuss how this issue may be dealt with in our empirical estimates.

First of all, we control for the presence of economies of scale in drinking water services by including a set of variables that measure the scale of production of the services. The population of a municipality, and its square, may serve such a purpose. Indeed, the larger the population, the higher the volume of water that must be produced. Furthermore, the quadratic term is a classic means of identifying possible economies of scale in applied econometric analysis. In addition, we include the variable *density*, and its square, which measure the density of the water distribution network as a means of addressing possible

²⁶For example, a report submitted to the UK water regulator OFWAT shows some empirical evidence on this issue for the water industry in England and Wales (Stone & Webster Consultants Ltd. (2004)). Using data between 1992-93 and 2002-03, the report found no evidence of economies of scale or scope between drinking water and sewage services. Using data obtained from water utilities in Wisconsin, Garcia et al. (2007) found no evidence for economies of vertical integration, even between the production and distribution of drinking water. However, this latter study does not attempt to assess economies of scale or scope for drinking water and waste water services.

economies of density. The interaction terms of these variables are also included to identify any economies of scale and density on water prices.

If there are synergies between water and sanitation services, there is no reason to consider that these should not be constant over time. Thus, these synergies should be accounted for by including municipality into our regression analysis. In addition, the operators' fixed effects will be used to run our regressions. In this way, any time-invariant synergies that a specific operator is able to exploit are accounted for. By controlling in our empirical analysis for time-invariant municipality and operator unobservable heterogeneity, the impact of the potential synergies may be neutralized if the latter are constant over time. The resulting estimate will therefore be likely to reflect a "relational contracting" effect.

Finally, the lagged water price may also serve as a proxy for the cost of running the drinking water service. This is because any synergy would be reflected in the cost of services, and water prices are correlated with such costs. As such, the lagged price could also be relied on to pick up any potential synergies between drinking water and sanitation services.

These considerations lead us to specify the following model for our econometric analysis:

$$\text{price}_{it} = \delta D_{it} + \alpha \text{price}_{it-1} + \mathbf{x}'_{it} \beta + u_i + v_{it} + w_t + \varepsilon_{it} \quad (4)$$

where price_{it} is the price paid by consumers (exclusive of taxes) per 120m³ of drinking water in municipality i in year $t \in \{1998, 2001, 2004\}$; D_{it} is a dummy variable that takes the value of 1 when drinking water and sanitation services in municipality i are bundled in year t , \mathbf{x}_{it} is a vector of observable variables that control for the characteristics of drinking water services in municipality i at time t ; u_i is a term that captures municipality i 's unobserved time-invariant heterogeneity; v_{it} represents the operator fixed effects; w_t represents the year fixed effects, and accounts for events in a particular year that have an impact on water prices in several different municipalities; lastly, ε_{it} is a potentially heteroskedastic regression error term. We assume that $\varepsilon_{it} \sim (0, \Sigma)$.

Our econometric specification has the potential to allow us to capture the effects of existing synergies, by identifying economies of any scale or scope. Hence, we may be reasonably confident that the estimate of δ will essentially capture the effect of contract bundling on drinking water prices on top of any

considerations of synergy.

5.2.2 Endogeneity issues

Another econometric difficulty that may arise is the possibility that D_{it} is endogenous. In particular, there may be individual heterogeneity in local public authorities or private operators that cannot be observed by the econometrician, but that is correlated both with the decision to bundle drinking water and sanitation services and with observed water prices. Failure to account for this dimension may lead to an inconsistent estimate for δ .

Any unobservable individual heterogeneity that results in the endogeneity of D_{it} may be either time-invariant or time-variant. To the extent that we account for time-invariant municipality and operator fixed effects in equation (4), we may be confident that any endogeneity bias that stems from those dimensions is taken into account in our estimate of equation (4). In this case, D_{it} will be uncorrelated with ε_{it} , and we will be able to obtain consistent estimates for the effects of bundling on drinking water prices *ceteris paribus*.

However, if the decision to bundle both services depends on some unobservable time-varying heterogeneity, any estimates obtained from equation (4) will no longer be consistent because D_{it} will be correlated with ε_{it} . In order to account for this potential source of endogeneity, we explicitly specify the following equation in order to study the decision of a municipality to bundle both services:

$$D_{it}^* = \mathbf{z}'_{it}\pi + \varphi_i + \mu_{it} \tag{5}$$

$$\text{Prob}[D_{it} = 1] = \text{Prob}[D_{it}^* \geq 0] = \text{Prob}[\mu_{it} \geq -\mathbf{z}'_{it}\pi - \varphi_i] = \Phi(\mathbf{z}'_{it}\pi + \varphi_i)$$

where D_{it}^* is a latent variable that could represent the propensity of a municipality to bundle both drinking water and sanitation services; \mathbf{z}_{it} is a vector of explanatory variables that influence the propensity of a municipality to bundle the two services together; π is a vector of coefficients; φ_i is a term that captures municipality i 's unobservable time-invariant characteristics; μ_{it} is an independently distributed standard normal error term such that $\mu_{it} \rightsquigarrow \mathcal{N}(0, 1)$ ²⁷; and $\Phi(\cdot)$ is the cumulative distribution function of a standard normal random variable. We further assume that φ_i is uncorrelated with \mathbf{z}_{it} and is distributed

²⁷Consistent with current practice in the literature, we normalize our Probit equation by the standard deviation of μ_{it} .

as a normal variable with mean 0 and variance σ_φ^2 . This specification corresponds to a random-effects probit model.

To the extent that unobservable time-varying individual heterogeneity that has an influence on observed water prices also drives a municipality to bundle the two services, μ_{it} will be correlated with ε_{it} . This will induce a correlation between D_{it} and ε_{it} . More formally, to address this potential source of endogeneity, we may specify the joint distribution of both regression error terms as:

$$\begin{bmatrix} \mu_{it} \\ \varepsilon_{it} \end{bmatrix} \rightsquigarrow \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \sigma_{\mu\varepsilon} \\ \sigma_{\mu\varepsilon} & \sigma_\varepsilon^2 \end{bmatrix} \right) \quad (6)$$

where $\sigma_{\mu\varepsilon}^2$ is the covariance between μ_{it} and ε_{it} ; and σ_ε^2 is the variance of ε_{it} from equation (4). A non-significant estimate for $\sigma_{\mu\varepsilon}$ would indicate an absence of unobservable time-varying individual heterogeneity in the decision to bundle both services. This system, composed of equations (4) and (5) is therefore more general, and allows us to account for the potential endogeneity of D_{it} .

Keeping in mind that our purpose is to obtain a consistent estimate for δ that accounts for the potential endogeneity of D_{it} , we estimate the system of equations using a two-step procedure. As shown by Heckman (1979), the issue of the endogeneity of D_{it} can be seen as a case of specification error due to “omitted variables.” Consistent estimates in this case may therefore be obtained by including estimated regressors for these “omitted variables.” To this end, we first run a random effects probit regression on equation (5). Following Heckman (1978) and Vella and Verbeek (1999), we then include the resulting generalized probit residuals in equation (4). This correction term should account for the potential endogeneity of D_{it} , and the associated coefficient corresponds to $\sigma_{\mu\varepsilon}$. Accounting for an endogenous D_{it} therefore leads us to estimate the following equation:

$$\text{price}_{it} = \delta D_{it} + \alpha \text{price}_{it-1} + \mathbf{x}'_{it} \beta + u_i + v_{jt} + w_t + \gamma \widehat{\lambda}_{it}(\mathbf{z}'_{it} \pi + \varphi_i) + \varepsilon_{it} \quad (7)$$

where $\gamma = \sigma_{\mu\varepsilon}$ and $\widehat{\lambda}_{it}(\cdot)$ is the estimated generalized Probit residual obtained from our regression on equation (5).²⁸

²⁸Alternatively, we could also have substituted D_{it} in equation (4) with its predicted value from our probit regression to

For our random effects probit regression, we will include all exogenous explanatory variables in equation (4) in the vector \mathbf{z}_{it} (apart from the lagged dependent variable in equation (4)), as well as other instruments to ensure identification. Supplementary instruments included in \mathbf{z}_{it} are the average percentage of votes for left-wing candidates in the 1995 and 2002 French presidential elections in the municipality concerned (the variable *LeftWing*), a set of dummy variables that indicates the period in which the contract for water services has been signed (before 1982, between 1982 and 1993, and after 1993), 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*). *LeftWing* is intended to capture the political and ideological aspects of using relational contracts by a municipality. Because these are political and ideological motivations for 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. The set of dummy variables that indicate the period in which the contract for water services has been signed is intended to capture some major changes in French legislation regarding the organization and provision of public services.²⁹ These laws may have a direct impact on the decision to bundle both services, and a less direct impact on water prices (since they do not directly regulate prices). Finally, *Instrument1* and *Instrument2* are directly inspired by Guasch et al. (2008). If we consider that the source of endogeneity might be the correlation between the decision to bundle the services and the error term, because of omitted characteristics of the contracting parties (Operators' characteristics) and of the contracts (Regional characteristics), these instruments are valid because the correlation between the choice to bundle services with a specific operator in a given region is only correlated to *Instrument1* through certain aspects, which by virtue of their construction are independent of those effects that are specific to the region concerned. Similarly, the choice to bundle services is only correlated to *Instrument2* through certain aspects, which by virtue of their construction are independent of effects that are specific to both the region and the operator concerned.

The following table provides definitions of all the variables used in the empirical model along with their descriptive statistics.

account for endogeneity between bundling the services and observed water prices (Heckman (1978); Vella (1998) etc.). We have also run regressions accounting for endogeneity using this approach and results are similar.

²⁹A decentralization law was introduced in March 1982 that granted municipalities a greater degree of autonomy in their policies. In 1993, the Sapin law (an anti-corruption law) was introduced to make it compulsory for municipalities to organize a public tendering if they wished to delegate a public service. This latter also places a ceiling on the duration of contract (a maximum of 20 years for water services).

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 |
| Bundle1 | 1 if an identical operator is used for drinking water and sanitation services, and if contracts are signed in the same year | 7002 | 0.31 | 0.46 | 0 | 1 |
| Bundle2 | 1 if an identical operator is used for drinking water and sanitation services, and if the water distribution contract is signed in the same year, or following the waste water contract. | 7002 | 0.38 | 0.49 | 0 | 1 |
| TreatA1 | 1 when the raw water does not need disinfection | 7002 | 0.52 | 0.5 | 0 | 1 |
| TreatA2 | 1 when the raw water needs disinfection | 7002 | 0.17 | 0.38 | 0 | 1 |
| Orig1 | 1 when the water comes from an underground source | 7002 | 0.16 | 0.36 | 0 | 1 |
| Orig2 | 1 when the raw water comes from a source on the surface | 7002 | 0.21 | 0.41 | 0 | 1 |
| Interco | 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 | Size of the population / Number of km in the network | 6895 | 141.47 | 278.22 | 0.70 | 11706.27 |
| Pop | Size of the population/10 000 | 7002 | 0.98 | 4.92 | 0 | 212.52 |
| Pop2 | Square of Population | 7002 | 25.17 | 939.26 | 0 | 45166.7 |
| RenewProg | 1 if there is an investment program | 7002 | 0.63 | 0.48 | 0 | 1 |
| Scarcity | Total volume distributed / (total volume distributed + imported) | 7002 | 0.88 | 0.24 | 0 | 1 |
| Limitation | 1 if consumed volume of water is constrained by regulation for some period of time during the year | 7002 | 0.07 | 0.26 | 0 | 1 |
| Tourist | Takes value 1 if the municipality is in a tourist area | 7002 | 0.13 | 0.34 | 0 | 1 |
| LeftWing | Average of percentage of votes for left wing parties in the 1995 and 2002 French presidential elections in the municipality | 6974 | 0.40 | 0.07 | 0.08 | 0.73 |
| D85 | 1 if a contract is signed before 1985 | 7002 | 0.17 | 0.37 | 0 | 1 |
| D8593 | 1 if a contract is signed between 1985 and 1993 | 7002 | 0.24 | 0.43 | 0 | 1 |
| D93 | 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 |
| Instrument 2 | Average prevalence of bundling at the time of contracting in different regions | 7002 | 0.53 | 0.15 | 0 | 0.65 |

5.2.3 Estimation strategy

We exploit the panel dimension of our data in including operator and year dummy variables in order to capture the potential operator time-invariant effects and events in each year of our observation that may have an impact on water prices in that year. In order to deal with municipality fixed effects, the Within Groups estimator or first-differencing transformation may be used to remove such effects. However,

because of the presence of price_{it-1} in equations (4) and (7), both transformations induce a correlation between the transformed lagged dependent variable and the transformed error term. Hence, the Within Groups estimator and the first-differencing transformation may still yield inconsistent estimates in our price equation. In particular, it has been shown in the literature that both transformations may lead to a downward bias for the estimate of α (Nickell (1981)).

Nevertheless, it is suggested in the literature that a first-differencing transformation should be used to remove the unobserved fixed effects. This yields in our case:^{30 31}

$$\Delta \text{price}_{it} = \delta \Delta D_{it} + \alpha \Delta \text{price}_{it-1} + \Delta \mathbf{x}'_{it} \beta + \Delta v_{jt} + \Delta w_t + \Delta \varepsilon_{it} \quad (8)$$

where Δ is the first difference operator. Notice that if D_{it} is correlated with u_i , the first-difference transformation allows us to obtain a consistent estimate for δ because the municipality fixed effects are removed after such a transformation (as long as the endogenous choice to bundle both services is only influenced by time-invariant unobservable municipality fixed effects). This is one of the points that we tried to make in the foregoing discussion.

In order to deal with the correlation that arises between the transformed lagged dependent variable and the transformed error term, Anderson and Hsiao (1981, 1982) suggest using instrumenting the now endogenous transformed lagged variable with the twice lagged dependent variable, i.e. price_{it-2} in our case. The result is a 2SLS estimate of equation (8). Arellano and Bond (1991), building on the former solution and on the work of Holtz-Eakin et al. (1988), propose that the orthogonality conditions between the transformed disturbances and instruments are exploited in order to obtain consistent estimates for equation (8). This yields the asymptotically efficient first-difference Generalized Method of Moments (GMM) estimator.³²

In our own empirical analysis, we will apply both techniques in order to obtain consistent estimates for equation (8). In particular, we will take advantage of the presence of explanatory variables in our regression and use them as supplementary instruments. In the following section, we present the results

³⁰For expositional simplicity, we will only focus on equation (4) in the remaining discussion in this subsection. The same treatment is applied to the estimation of equation (7).

³¹The first-differencing transformation is preferred in this case since the Within Group transformation introduces all previous realizations of the error term into the transformed error term (Bond (2002)).

³²For a review of these econometric techniques, the interested reader is referred to Bond (2002).

of our estimations and discuss their implications.

5.2.4 Estimation results and discussion

Table 2 shows our estimates of the impact of bundling drinking water and sanitation services on the prices paid by consumers in a given municipality.³³ The variables of interest in these regressions are the estimated coefficients *Bundle1* and *Bundle2*. The former is equal to 1 when the contracts for drinking water and sanitation services are granted to an identical operator *in the same year*, while the latter allows for this condition to occur in a more general sense. More specifically, *Bundle2* will take a value of 1 if an identical operator is used for both drinking water and sanitation services, and if the water distribution contract is signed in the same year or after the sanitation contract. We treat the bundling decision as exogenous in these regressions.

Columns (1)-(4) show the estimates for equation (4) using normal econometric techniques, i.e. OLS, panel random effect, Within Groups estimator and first-differencing transformation. We do not account for the potential endogeneity of the transformed lagged dependent variable in these estimates. In columns (5)-(8) we have tried to correct for any inconsistency that may arise due to the correlation between the transformed lagged dependent variable and the transformed error term. In column (5) we use the Anderson and Hsiao estimator, instrumenting $\Delta price_{it-1}$ with $price_{it-2}$ and Δx_{it-1} . In columns (6) and (7) we implement the first-difference GMM proposed by Arellano and Bond (1991). The difference between these columns arises from the dependent variable used in the regressions: in column (6) the dependent variable is the price paid for drinking water by consumers, while in column (7) we use the logarithm of the price as the dependent variable. In the regressions for columns (1) to (7), we use *Bundle1* as our measure of horizontal bundling. In column (8), we consider another measure for a municipality's bundling decision i.e., *Bundle2*.³⁴

Estimates for $price_{it-1}$ from various columns in Table 2 correspond to what may be expected in the presence of a correlation between the transformed lagged dependent variable and the transformed error term.

³³Note that we lost a year of observations (1998) because of the inclusion of the lagged dependent variable in our regressions.

³⁴Regressions that distinguish between contracts that are signed in the same year for an identical operator from cases where the operator's water distribution contract is signed after his sanitation contract show that both variables have a significant and similar negative effect on observed water prices. We are unable to reject the hypothesis that both variables impact observed water prices differently using a Wald test.

Table 2: Estimation results for equation (4)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|------------------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|----------------------|-------------------------|----------------------|
| | OLS | Random Effects | Within | First Difference | Anderson & Hsiao | GMM-DIF | GMM-DIF | GMM-DIF |
| Dep. Var. | Price | Price | Price | Price | Price | Price | ln Price | Price |
| Bundle1 | -3.730*** (0.971) | -5.089*** (1.098) | -4.109* (1.667) | -3.645* (1.666) | -3.264+ (1.803) | -4.026* (1.709) | -0.027* (0.012) | |
| Bundle2 | | | | | | | | -5.268** (1.687) |
| Price _{t-1} | 0.771*** (0.017) | 0.5337*** (0.022) | -0.135*** (0.030) | -0.180*** (0.036) | 0.136* (0.053) | 0.133** (0.042) | 0.175*** (0.031) | 0.130** (0.042) |
| TraitA1 | -0.186 (1.238) | -1.475 (1.471) | 6.138* (2.452) | 7.600** (2.566) | 7.668** (2.644) | 8.177** (2.521) | 0.063*** (0.018) | 8.353*** (2.514) |
| TraitA2 | 1.747 (1.327) | 3.257* (1.431) | 2.724 (1.771) | 2.347 (1.807) | 2.160 (1.914) | 1.754 (2.140) | 0.009 (0.015) | 1.898 (2.135) |
| Orig1 | 8.362*** (1.460) | 13.029*** (1.681) | 6.910* (3.260) | 0.336 (4.655) | -0.265 (4.926) | -2.740 (4.231) | -0.030 (0.031) | -2.590 (4.218) |
| Orig2 | 1.107 (1.335) | 4.077** (1.547) | 3.571 (2.912) | -0.922 (3.648) | -1.138 (3.618) | -1.988 (3.379) | -0.010 (0.024) | -1.983 (3.370) |
| Intermunicipality | 4.050*** (1.032) | 8.393*** (1.247) | 4.696 (2.973) | 4.607 (2.943) | 4.126 (2.938) | 4.101 (2.638) | 0.041* (0.019) | 4.054 (2.631) |
| RenewProg | 0.543 (0.861) | 0.755 (0.969) | -0.709 (1.024) | -1.501 (1.045) | -0.756 (1.096) | -0.920 (1.015) | -0.007 (0.007) | -0.866 (1.012) |
| Scarcity | -4.748* (1.857) | -6.194** (2.276) | -4.546 (4.429) | -7.459+ (4.372) | -1.137 (4.492) | -3.456 (3.906) | -0.035 (0.028) | -3.521 (3.896) |
| Limitation | 4.259** (1.595) | 2.817+ (1.445) | -1.949 (1.354) | -3.334* (1.458) | -1.792 (1.485) | -1.970 (1.489) | -0.008 (0.011) | -2.031 (1.486) |
| Touristic | -1.989+ (1.203) | -0.505 (1.396) | 5.561* (2.636) | 6.760* (2.879) | 5.212+ (2.900) | 5.215+ (2.902) | 0.031 (0.021) | 5.468+ (2.896) |
| Density | -0.021*** (0.004) | -0.025*** (0.005) | | | | | | |
| Density ² | 0.000*** (0.000) | 0.000*** (0.000) | | | | | | |
| Pop | -1.696*** (0.385) | -1.938*** (0.536) | | | | | | |
| Pop ² | -0.002 (0.002) | -0.002 (0.002) | | | | | | |
| Density × Pop | 0.004*** (0.001) | 0.004*** (0.001) | | | | | | |
| (Density × Pop) ² | -0.000*** (0.000) | -0.000** (0.000) | | | | | | |
| Constant | 55.383*** (5.244) | 84.407*** (6.204) | 188.684*** (8.657) | 13.925*** (0.661) | 10.816*** (0.797) | | | |
| Year dummy var. | Yes | Yes | Yes | No | No | Yes | Yes | Yes |
| Operator dummy var. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Endog. var | - | - | - | - | Price _{t-1} | Price _{t-1} | ln Price _{t-1} | Price _{t-1} |
| Sargan test of overid. rest. | - | - | - | - | 13.46 (11) | 0.40 (1) | 0.00 (1) | 0.39 (1) |
| χ ² (df) | | | | | (0.264) ^c | (0.526) ^c | (1.000) ^c | (0.531) ^c |
| R ² | 0.671 ^a | 0.658 ^a | 0.234 ^b | 0.071 ^a | - | - | - | - |
| N | 4671 | 4671 | 4694 | 2176 | 2106 | 2176 | 2168 | 2176 |

Standard errors within parentheses.

Huber/White/Sandwich standard errors are given in columns (1), (2), (3), (4), (5) and (6).

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

Note: ^a R² overall, ^b R² within, ^c p-value for Sargan statistics.

In particular, OLS estimates are biased upwards in this case, while Within Groups and first-differencing transformations are biased downwards. We observe from Table 2 that the OLS estimate for price_{it-1} is positive while the Within Groups estimate and the first-difference estimate of this variable are negative. The use of either the Anderson and Hsiao or the first-difference GMM estimator (columns (5) and (6)) to account for the endogeneity of price_{it-1} produces estimates that lie between the OLS estimate (column(1)) and the Within Groups and first-difference estimates (columns (3) and (4)). Our results show a clear need to account for the endogeneity of Price_{it-1} in our estimates. It should also be noted that we are unable to reject the null hypothesis in the Sargan test for overidentifying the restrictions in columns (5) to (8), which suggests that our instruments are globally valid. The estimated coefficient in these estimations (columns (5) to (8)) indicates at least a positive correlation between present and lagged prices over time.

Furthermore, our estimates appear to show that unobservable municipality fixed effects are present in our data. The results of our regression show that the estimates made for some of the variables change radically when the potential correlation between municipality fixed effects and various explanatory variables are taken into account in the regressions. This is the case for *TraitA1*, *Orig1*, *Orig2*, and *Touristic*. These changes may indicate the presence of municipality fixed effects.

It is interesting to note that despite the presence of fixed effects, estimates for *Bundle1* are fairly stable throughout the regressions (columns (1) to (6)). This may be an indication that *Bundle1* is not correlated with the municipality fixed effects. In other words, it would appear that the decision to bundle the two services together is not driven by the unobservable time-invariant characteristics of the municipality.

Rather more in keeping with the aims of our empirical analysis, the estimates show that consumers in municipalities where an identical operator is used for both drinking water and sanitation services pay a lower price for their drinking water services overall. This effect is significant in all our regressions, and works out at around 3.5 euros per 120m³ of drinking water consumed. This represents about 2.7% of the price for drinking water paid by consumers (according to column (7) of Table (2), in which we use the logarithm of price as the dependent variable).

It is worthy of note that we find a similar effect using a slightly different measure of bundling. As shown in column (8), the estimate for *Bundle2* is both significant and negative. The estimate indicates that observed water prices are lower overall by about 5 euros per 120m³ in municipalities where an identical

operator is used for both drinking water and sanitation services, regardless of whether both contracts have been granted in the same year, or if the water distribution contract has been granted after the contract for sanitation services.

We are reasonably confident that the estimates described above reflect the effect of the “relational contract” due to the bundling of drinking water and sanitation services, because we have controlled for the presence of economies of scale and/or scope for both services by including various fixed effects and lagged prices. As we have previously argued, the first of these should account for any potential synergies between the two services provided that these synergies are time-invariant, while the second should account for any effects due to synergies that vary over time. We therefore believe that the estimated effect of D_{it} on the observed prices for drinking water services occurs over and above any considerations of potential synergies. The estimated signs of these coefficients are consistent with our theoretical propositions that were based on relational contracts.

Nevertheless, the estimates in Table (2) treat D_{it} as exogenous.³⁵ We now relax this assumption. Table (3) shows estimation results that take the potential endogeneity of D_{it} into account. The results for our random effects probit estimation for *Bundle1* (resp. *Bundle2*) are shown in column (A) (resp. column (C)) in Table (3). Column (B) (resp. column (D)) shows estimates of our price equation that account for the potential endogeneity of *Bundle1* (resp. *Bundle2*): we have used the estimated generalized probit residuals from column (A) (resp. column (C)) to estimate the price equation in column (B) (resp. column (D)).

It may be seen from Table (3) that the exogenous variables that we have included in the bundling equation and excluded from the price equation are all significant (except for *LeftWing* in column (C)). However, the goodness of fit of these probit regressions is generally weak, in particular for the estimates shown in column (A).

Before discussing the estimates of the price equations, we first turn our attention to the impact of our variable *Touristic* on the probability that drinking water and sanitation services are bundled. Our estimates

³⁵Such an assumption is justified to the extent that the decision to bundle is motivated by explanatory variables that are included in our regression and/or by unobservable time-variant heterogeneity at the level of the municipality and/or operator. The estimates in Table (2) will not have any consistency if the unobservable time-varying heterogeneity that drives the decision to bundle also has an influence on observed water prices.

Table 3: Estimation results accounting for endogenous horizontal bundling

| Dep. Var. | (A) | (B) | (C) | (D) |
|---|--------------------------|----------------------|--------------------------|----------------------------------|
| | Random Effects Probit | GMM- DIF | Random Effects Probit | GMM- DIF |
| | Bundle1 | Price | Bundle2 | Price |
| Price _{t-1} | | 0.129** (0.044) | | 0.124** (0.044) |
| Bundle1 | | -11.028** (3.792) | | |
| Bundle2 | | | | -8.722*** (2.556) |
| TraitA1 | 0.046 (0.180) | 7.823** (2.515) | 0.139 (0.202) | 8.026** (2.507) |
| TraitA2 | 0.139 (0.178) | 1.806 (2.123) | 0.151 (0.208) | 1.963 (2.116) |
| Orig1 | 0.030 (0.251) | -0.565 (4.220) | 0.273 (0.312) | -0.232 (4.203) |
| Orig2 | -0.011 (0.222) | 0.096 (3.363) | -0.145 (0.264) | 0.134 (3.353) |
| Inter- municipality | -1.189*** (0.173) | 3.292 (2.651) | -1.461*** (0.218) | 3.595 (2.623) |
| ProgRenouv | 0.086 (0.097) | -0.650 (1.006) | 0.253* (0.107) | -0.488 (1.003) |
| Scarcity | 0.601* (0.245) | -5.081 (3.922) | 0.502+ (0.289) | -5.640 (3.892) |
| Limitation | -0.043 (0.160) | -1.437 (1.479) | -0.096 (0.175) | -1.584 (1.474) |
| Touristic | 1.471*** (0.241) | 6.753* (2.946) | 2.188*** (0.289) | 7.038* (2.990) |
| LeftWing | 2.265+ (1.231) | | 2.186 (1.592) | |
| D85 | -1.020*** (0.247) | | -1.842*** (0.304) | |
| D93 | 0.835*** (0.161) | | 1.669*** (0.197) | |
| Instrument1 | -3.718* (1.859) | | -7.467*** (2.182) | |
| Instrument2 | 3.483*** (0.990) | | 5.211*** (1.137) | |
| Density | 0.001 (0.001) | | 0.001+ (0.001) | |
| Density2 | -0.000 (0.000) | | -0.000 (0.000) | |
| Pop | 0.733*** (0.135) | | 1.056*** (0.146) | |
| Pop ² | -0.008** (0.003) | | -0.011** (0.004) | |
| Density × Pop | -0.002*** (0.000) | | -0.002*** (0.000) | |
| (Density × Pop) ² | 0.000*** (0.000) | | 0.000*** (0.000) | |
| Const. | -6.088*** (0.973) | | -7.404*** (1.118) | |
| Generalized Probit Residuals | | 2.466* (1.257) | | 1.295 (0.813) |
| Year dummy variables | Yes | Yes | Yes | Yes |
| Operator dummy var. | Yes | Yes | Yes | Yes |
| Endog. Var. | - | Price _{t-1} | - | Price _{t-1} |
| Sargan test overid. restr. $\chi^2(df)$ | - | - | - | 0.18 (1) (0.672) ^a |
| Pseudo R ² | 0.08 | - | 0.11 | - |
| N | 6867 | 2149 | 6867 | 2149 |

Standard errors within parentheses. Significance level: + 10% *5% ** 1% *** 0.1%.

Note: ^a p-value for Sargan statistics.

show that this variable is positively correlated with the probability that the two services are bundled, all other things being equal. To the extent that it may be argued that this variable may serve as a proxy for uncertainty (because of the inherent seasonal variations in water demand represented by this variable), such an estimate is consistent with our explanation using relational contracts. Indeed, higher levels of uncertainty may lead to a greater need for *ex post* adaptations and flexibility in managing the provision of services. Relational contracts may be particularly important in this case, because they may facilitate *ex post* coordination and cooperation. Hence, one may expect the parties concerned to resort to bundling to improve relational contracts in this case.

The estimated inter-equation covariance (given by the coefficient associated with the generalized probit residual) is statistically significant in column (B) but not in column (D). This suggests that *Bundle1* may be endogenous, while *Bundle2* can be considered as exogenous.³⁶ This observation may reflect the fact that those municipalities that have granted both contracts for drinking water and sanitation services to an identical operator in the same year deliberately chose to do so. Indeed, in order to pursue such a strategy, municipalities must fix the duration of the two contracts to ensure that they are granted to the operator in the same year. This may therefore lead to some non-randomness in *Bundle1*, and result in some endogeneity.

Furthermore, the estimates show that the error terms that occur between the bundling equation and the price equation are positively correlated when we use *Bundle1* as measure of horizontal bundling. Any unobservable time-varying heterogeneity that leads a municipality to bundle both services will also tend to have a positive impact on observed drinking water prices.

More importantly, having accounted for potential endogeneity, the impact of bundling on the drinking water prices paid by consumers becomes greater. This is particularly true for those services that are granted in the same year to an identical operator. Indeed, the estimate for *Bundle1* is now greater in terms of its absolute value compared with the results shown in Table (2); consumers in these municipalities pay on average 11 euros less, all other things being equal (column (B)). Note also that the estimate for *Bundle2* in column(D) (accounting for potential endogeneity) is also higher in absolute terms than that obtained under the assumption that D_{it} is exogenous, although the difference between the two estimates is substantially smaller. This is consistent with the previous observation that *Bundle2* is not endogenous.

³⁶Note that the estimated coefficient associated with the generalized probit residual in column (D) is significant at 15%.

To conclude, our results suggest that water prices are lower in those municipalities where drinking water and sanitation services are bundled. This finding remains robust even when we attempt to control for other factors such as the synergies that may exist between the two services, and when we attempt to address various other issues of endogeneity. While the estimated size of this impact varies according to different specifications and underlying assumptions, all our estimates show that bundling negatively affects the drinking water prices paid by consumers, in agreement with the theoretical analysis that we have developed in this article.

6 Conclusion

In this article, we sought to understand why local public authorities tend to choose the same operator for different services. We suggest that such a bundling strategy may be desirable because it improves the efficiency of relational contracts that exist between local public authorities and private operators. This does not imply a need to bundle all services, but justifies why there may be some advantage in bundling two (or more) services with different cost characteristics, in order to limit any damage to quality caused by contractual incompleteness. To illustrate this, we have proposed a model that is rooted in the literature on incomplete contracts. We then showed that under some conditions, the bundling of services leads to better performance at lower cost for the public authority. This may be explained by the fact that relational contracts are more easily sustained under these conditions, because any deviations from the relational contracts can be more severely punished. We then made an assessment of the empirical relevance of our findings using data from the French water industry. In particular, the results of our regressions show that drinking water prices are significantly lower when the same operator is in charge of providing waste water services, *ceteris paribus*. This empirical result is robust for a variety of conditions and is consistent with our thesis on relational contracts even if our results cannot tell whether services are provided more efficiently, at a lower cost or both.

Although our study focuses on the water sector, our results could have some practical relevance in other public services, and some applications in different sectors clearly deserve some further attention in this regard. However, we shall reserve such considerations for future work.

On the whole, our study suggests that informal dealings and relational contracts are important dimensions in making contracting choices, especially for PPPs, in a world where it is impossible for either contracting party to anticipate the contingencies that may arise throughout the lifetime of a contract. These uncertainties should be addressed when considering the use of PPPs for the provision of any public service.

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Appendix A

Once the manager has reneged on his informal commitment, he is chosen in subsequent periods with a probability $p \in [0; 1]$. This implies that in each period, his expected gain is pU_s^{NB} where s denotes the service \mathcal{B} in the case of unbundling, and denotes the services \mathcal{A} and \mathcal{B} in case of bundling. We note that such a probability is applied at each contract renewal, whether he has been chosen in the 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:

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

$$\begin{aligned} \text{It then comes: } U_{t,s}^{M,E} &= pU_{t,s}^{M,NB} + \delta pU_{t+1,s}^{M,E} + (1 - p)\delta U_{t+1,s}^{M,E}U_{t,s}^{M,E} = pU_{t,s}^{M,NB} + \delta pU_{t+1,s}^{M,E}U_{t,s}^{M,E} = \\ & pU_{t,s}^{M,NB} + \delta p[U_{t+1,s}^{M,NB} + \delta U_{t+2,s}^{M,E}]U_{t,s}^{M,E} = pU_{t,s}^{M,NB} + \delta p[U_{t+1,s}^{M,NB} + \delta U_{t+2,s}^{M,E}]U_{t,s}^{M,E} = pU_{t,s}^{M,NB} + \\ & \delta pU_{t+1,s}^{M,NB} + \delta^2[U_{t+2,s}^{M,E} + \delta^2 U_{t+3,s}^{M,E}]U_{t,s}^{M,E} = pU_{t,s}^{M,NB} + \delta pU_{t+1,s}^{M,NB} + \delta^2 U_{t+2,s}^{M,NB} + \delta^3 U_{t+3,s}^{M,E} \end{aligned}$$

By recurrence, 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 because he will choose a level of investments that maximizes his own present payoff, instead of the first-best level.

For the next periods, he expects a discounted gain $U_{t,s}^{M,E}$. This can be written 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

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

From Equation (2), we can deduce that

$$\delta U_{\mathcal{B}}^{PA,FB} - \delta p U_{\mathcal{B}}^{PA,NB} - \delta(1-p)U_{\mathcal{B}}^{PA,oo} \geq T_{\mathcal{B}} \quad (9)$$

and Equation (3) provides a lower bound to $T_{\mathcal{B}}$:

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

We must now prove that (4) > (3), i.e.

$$\begin{aligned} \delta U_{\mathcal{B}}^{PA,FB} - \delta p U_{\mathcal{B}}^{PA,NB} - \delta(1-p)U_{\mathcal{B}}^{PA,oo} &\geq \delta(p-1)U_{\mathcal{B}}^{M,NB} + U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB} \\ \delta U_{\mathcal{B}}^{PA,FB} - \delta p U_{\mathcal{B}}^{PA,NB} - \delta(1-p)(U_{\mathcal{B}}^{PA,oo} - U_{\mathcal{B}}^{M,NB}) &\geq U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB} \\ \delta U_{\mathcal{B}}^{PA,FB} - \delta p U_{\mathcal{B}}^{PA,NB} + \delta(1-p)U_{\mathcal{B}}^{M,NB} + \delta(p-1)U_{\mathcal{B}}^{PA,oo} &\geq U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB} \\ U_{\mathcal{B}}^{PA,FB} - p U_{\mathcal{B}}^{PA,NB} + (1-p)U_{\mathcal{B}}^{M,NB} + (p-1)U_{\mathcal{B}}^{PA,oo} &\geq \frac{1}{\delta}(U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB}) \\ U_{\mathcal{B}}^{PA,FB} + (1-p)U_{\mathcal{B}}^{M,NB} + \frac{U_{\mathcal{B}}^{M,FB}}{\delta} &\geq p U_{\mathcal{B}}^{PA,NB} + (1-p)U_{\mathcal{B}}^{PA,oo} + \frac{1}{\delta}U_{\mathcal{B}}^{M,NB} \\ S^{FB} - U_{\mathcal{B}}^{M,FB} + (1-p)U_{\mathcal{B}}^{M,NB} + \frac{U_{\mathcal{B}}^{M,FB}}{\delta} &\geq (1-p)U_{\mathcal{B}}^{PA,oo} + \frac{1}{\delta}U_{\mathcal{B}}^{M,NB} + p(S^{NB} - U_{\mathcal{B}}^{M,NB}) \\ S^{FB} + U_{\mathcal{B}}^{M,NB} + \frac{(1-\delta)U_{\mathcal{B}}^{M,FB}}{\delta} &\geq (1-p)U_{\mathcal{B}}^{PA,oo} + \frac{1}{\delta}U_{\mathcal{B}}^{M,NB} + pS^{NB} \\ S^{FB} - pS^{NB} + (1-\frac{1}{\delta})(U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB}) &\geq (1-p)U_{\mathcal{B}}^{PA,oo} \end{aligned}$$

$$S^{FB} - pS^{NB} - (1-p)U_{\mathcal{B}}^{PA,oo} + (1-\frac{1}{\delta})(U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB}) \geq 0 \quad (10)$$

We recall that p denotes the probability that the private operator will be chosen again at the next contract

renewal once he has deviated. As a consequence, $0 \leq p \leq 1$.

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

$$S^{FB} - U_{\mathcal{B}}^{PA,00} + (1 - \frac{1}{\delta})(U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB}) \geq 0 \quad (11)$$

(11) is true because

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

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

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

$$S^{FB} - S^{NB} + (1 - \frac{1}{\delta})(U_{\mathcal{B}}^{M,NB} - U_{\mathcal{B}}^{M,FB}) \geq 0 \quad (12)$$

(12) is true because

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

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

In conclusion, whatever the value of p , (10) is true, which means that there exists a positive interval in which $T_{\mathcal{B}}$ lies.

Appendix C

Table 4: Share and average water prices of French municipalities using the same operator for drinking and sanitation services (Calculation by the authors)

| | Signed | Signed | Total | Average price | | | |
|---------------------|--------------------|---------------|-------|---------------|--------|--------|--------|
| | at different years | the same year | | 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 |

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