Providing public utilities in a common agency framework: making, buying and level of association.

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Abstract

As public service providers, local governments have to deal with three issues: the global quality of the considered service, the production mode either in-house or private, and the level of association with other local governments. We use a Principal-Agent LEN framework with moral hazard to model the three identified levels of association : "commune", "syndicat" and "communauté de commune", and the two possible modes of production: public (in-house) and private (outsourcing) in the French Water Industry. We show that the production mode is not sufficient to explain price differences: the level of association is a crucial determinant of cost structures. This model makes it possible to clarify the tradeoffs faced by local governments, and allows us to identify the major drivers of their choice namely the power of the scale (dis)economies and the magnitude of their accountability. Using data from 15000 French drinking water providers, we test these theoretical results by benchmarking the combinations between public/private and the three levels of association. Our results suggest that the organizational form explains the largest variations in the efficiency of local public services.

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Economists in building up a theory have often omitted to examine the foundations on which it was erected. Ronald Coase, 1937.

1 Introduction

Local governments are in charge of the provision of several public goods and services such as hospitals, prisons, water services, border control, etc. For each of these services the government has to make three different choices namely (1) its ambition about the global quality of the delivered good or service, (2) the production mode, either public or private, and (3) whether or not it wishes to get together with other governments to jointly provide the service. On one hand, our paper provides an original theoretical model explaining the tradeoffs coming with these choices and makes it possible to have a clear understanding of the cost structures associated with the different modes of production and levels of association. On the other hand, using data on the french water services an empirical approach confirms the theoretical results and show that modes of production and levels of association are major determinants of the cost structures.

The water industry is the illustration frequently used in both theoretical and empirical literature on delegated management and public/private ownership (Martimort and Sand-Zantman (2006) and Chong, Saussier, Silverman (2012) are particularly relevant for us). The water industry is a good illustration of our framework, well-stocked with data and eases the comparison of our results with other contributions. Our model and results, yet, can be applied to a large scope of public goods and services at different local governmental levels : town, state, etc. We develop in an extension several other applications.

The local government has to choose the mode of production. It can either provide the service in-house using civil servants or delegate the work to a private firm. In France a direct public management is called "régie" and in 2016 on the 15,000 local public authorities identified in our data about one third are private and the rest are public. The other choice the local government has to make concerns the level of association. In practice the government has three possibilities : provide alone, create an association with other local governments or leave the responsibility of the public service to an other political entity. These three configurations can be identified in the drinking water industry in France. The first case scenario corresponds to the municipal management, the municipality deals with the water provision alone. The second case is the one of the "syndicats" where municipalities join an association to share some competencies and provide a common water service. The last configuration corresponds to the "communauté de communes" where municipalities transfer their competencies to an other political entity who is responsible for the water service for several local governments. In 2016, in France, among the 15,000 local public authorities 71 % are municipalities, 27 % are association and 2 % are communities.

Both the modes of production and the levels of association seem to be key determinants of the cost of services and selected quality. Since the nineties the french government has targeted these elements to improve the management

of local public services. For instance, the "Loi NOTRE" of 2015 encourages communal associations and the "Loi SAPIN" makes the choice of the production mode more flexible. Nevertheless these key elements have not been taken into account simultaneously. The main contribution of our article is to provide an unified model of the choice of the local government of the production modes and the levels of association.

We assume the local governments to be risk averse. Lewis and Sappington (1995) use this assumption to model financial constraints on the government's side. In our model this assumption makes it possible to take into account the difficulty for the government to diversify the risk associated with public service providing. A portfolio manager with a small available budget is more likely to put all her eggs in one basket. An alternative interpretation is the following : consider a local government where tax payers give high priority to drinking water. A failure is dramatic for the public authority since it will not be able to fully compensate the loss with something else.

To introduce our model of the different levels of association let us come back to the water industry illustration. There is no fundamental difference between the lowest association level where the local government provides the service alone and the highest level of association where a "communauté de communes" provides the service for the members. In both cases there is one authority choosing the quality of the service for its area. The only difference is a matter of size. Therefore the model of the highest association level shouldn't differ from the one used for the lowest association level. This is not the case for the medium level of association corresponding to the "syndicats". In this configuration several local governments join to produce a common service and strategically interact. To model this we use a common agency framework where each local government chooses its quality and negotiates with a common agent, public or private, and, through him, with the other local governments.

The local government no matter what is the selected mode of production does not do the job by itself. The one who produces the public service is the civil servant or the firm. We assume that the agent (civil servant or firm) undertakes a non verifiable operating effort and moral hazard appears. There is non reason to think, a priori, that the local government is more able to observe what the civil servant is doing. What the local government do observe is a signal of the provided quality of the service and there is, once more, no reason to think that this signal is more informative under public production. Therefore, since the only available tool for the local government is the signal about the quality of the service, there will be no difference between a public and a private mode of production at the municipal management level nor at the "communauté de communes" level. The difference between a public and a private production appears at the medium level of association. Indeed, in a "syndicat" there is not one quality chosen, one signal, but as many as participants. The public or private nature of the production determines the number of signals available to the local governments to design their incentive schemes. In a public production mode each local government keep an authority relationship to the common agent who is a civil servant (or a group of civil servants) and can condition his payment

not only to the signal observed in his area but also to those associate to its neighbors to manipulate the agent's effort. In contrast, in a private production mode even if the other signals are observable the local government can not contract upon them because the authority is shared by all the members of the associations when it comes to the negotiation with the private firm.

Our model makes it possible to make prediction about the different cost associated to the modes of production and levels of association and have an understanding of the tradeoffs coming with the choices among these structures. First, the costs of public and private production of a public service is equal at the lowest level of association – community level – and at the highest level of association - "communauté de commune" ; and that the cost at the medium level of integration - "syndicat" - is higher under a private mode of production. Second, the local government chooses to stay alone only if the agent's effort for one government hardens the effort for the other (efforts are substitutes). The local government chooses to transfer is competence only if it exhibits a large risk aversion and the spin of received from the "communauté de commune" are high enough. Choosing between private and public mode of production in a "syndicat" the local government faces a tradeoff between cost of the effort reduction and cost of risk increase. A government willing to diminish the cost of effort chooses the public production mode.

The main contribution of our work is to bridge the gap between two literary traditions particularly relevant for the public sector : the common agency problems and the choice between private and public production. The common agency problem has been introduced by Bernheim and Whinston (1986) and arise when several principals enter in a relationship with a single agent. Such a configuration leads to strategic behaviors on the principals' side since each one of them is willing to manipulate the common agent in her own interest. Bernheim and Whinston (1986) as well as Dixit (2002) identify public sector as a fertile ground for such multi-principal configurations. Closer to our model Holmström and Milgrom (1988), in a moral hazard framework, find equilibrium with linear payments for two principals. These results are extended by Dixit (1996, 1997) to several principals and other forms of cost functions. The main tradeoff associated with common agency in the moral hazard literature stands between gains when the efforts ordered by the principals are complements and negative externalities due to the strategic game between principals. The multi-principal problem with adverse selection has been developed by Martimort (1992) and Stole (1991). Adverse selection leads to some technical questions but the overall effect of common agency is similar to the one underlined with moral hazard.

The choice between a public and a private production mode is a recurrent issue for public sector observers. The main interrogation relies upon the relative efficiencies of those production modes and the final trade-off is between productive efficiency and transaction costs. Note that this trade-off is similar to the one identified in the common agency literature. A choice has to be made between productive efficiency and cost of contracting. The transaction cost tradition with Williamson (1985) and Hart, Shleifer and Vishny (1997) gave a major contribution to model this issue. Hart, Shleifer and Vishny, in particular, provide

clear intuitions of the difference between a public and a private organization. In an incomplete contract framework they analyzed the effect of residual control rights à la Grossman and Hart (1986) on specific investments. In their work a public production mode is characterized by the fact that the public manager has the residual control right and then can extract the rent of her agent who thus faces weak incentives. In contrast when the residual control rights is left to the private operator the incentives are stronger but she can invest in harmful activities from the principal's point of view. An alternative way to model the different production modes can be found in Levin and Tadelis (2010) where the public or private nature of the production comes from the selected optimal contract. This results from the fact that the amount of hours worked by the agent is a public information whereas the effort which stay private informaion. In Levin and Tadelis (2010) a public production mode exhibits weaker incentives and productive efficiency but lower transaction cost since the principal can avoid the moral hazard problem. In our model there is no public information or residual control rights . Therefore no matter what is the productive mode the principal faces a moral hazard situation. We assume that there is a particular authority relationship with a civil servant in a public production mode. This particular relationship makes it possible for the principal to use different signals and therefore manipulate the cost of the agent's effort. The local authority faces a trade-off between lower production cost and higher cost associated to the risk because of the strategic game it plays with the other governments.

2 Theoretical Model

We use a Principal-Agent model with Moral Hazard and risk averse protagonists based on linear compensation, negative exponential utility functions, and normally distributed performance measure (LEN-Model). The condition for such a scheme with linear payment to be truly optimal are quite difficult to meet, these conditions are given by Holmström and Milgrom (1987). Nevertheless this framework is robust to manipulation, gives simple intuition and is particularly useful to model common agency problems (see Dixit (2002)).

2.1 Municipal management, low level of association and baseline case

The municipality is caracterized by a local government seeking to provide a public service, there is no common agency problem, it will be our baseline case. The local government can either choose to use her civil servants to do the job or to delegate the service to a private operator. Principal (local government) and agent (public or private) exhibits CARA-type utility functions noted respectively M and U and described below. CARA stands for constant absolute risk aversion, CARA-type utility functions insure concavity of the utility, make it possible to derive clear intuitions regarding risk aversion and is analytically convenient. The coefficient of risk aversion of the agent is noted r, the corre-

sponding coefficient for the principal is noted R. The principal is assumed to be risk averse to model financial constraints on the government's side. To clarify this intuition consider a local government where tax payers give high priority to drinking water. A failure is dramatic for the public authority since it will not be able to fully compensate the loss with something else.

$$\begin{cases} M_L = 1 - exp\{-R[x - t - wx]\} \\ U_L = 1 - exp\{-r[t + wx - \frac{c}{2}a^2]\} \end{cases}$$

The local government values the quality of service which is the effort of the agent a. Yet the local government is not able to observe this effort directly. This hidden action of the agent creates moral hazard. To design the incentive scheme the principal can only rely upon a signal informative about the agent's action $x = a + \epsilon$ where ϵ is the term of error ($E(\epsilon) = 0$, $V(\epsilon) = \sigma$). The principal pays to the agent a transfer with a fix part t and a variable part w depending on the effort a exerted by the Agent. The agent values the transfer and endures a quadratic cost function increasing and convex in a. The local government no matter what is the selected mode of production does not do the job by itself. The one who produces the public service is the civil servant or the firm. There is non reason to think, a priori, that the local government is more able to observe what the civil servant is doing. What the local government do observe is a signal of the provided quality of the service and there is, once more, no reason to think that this signal is more informative under public production. Since the only available information for the Principal is x there is no difference in that case between private and public organization. Therefore, we claim that the Principal's choice between public and private organization at the community level of integration is exclusively a political question. To find the linear incentive scheme selected by the Principal we have to use the expected utility functions[1].

$$\begin{cases} E[M_L] = 1 - exp\{-R[a(1-w) - t - \frac{R}{2}(1-w)^2\sigma]\} \\ E[U_L] = 1 - exp\{-r[t + wa - \frac{c}{2}a^2 - \frac{r}{2}w^2\sigma]\} \end{cases}$$

The Agent chooses the level of effort a_L which maximises her expected utility it is the incentive compatibility constraint.

$$a_L = \frac{w}{c}$$

The value of t is selected to saturate the participation constraint

$$t_L = -wa_L + \frac{c}{2}a_L^2 + \frac{r}{2}w^2\sigma$$

Using the two previous equations to rewrite the Mayor's problem we finally derive the variable part of the transfer.

$$w_L = \frac{1 + Rc\sigma}{1 + c\sigma(r + R)}$$

[1]See the resolution in the appendix

This is the canonical result of a LEN model with risk averse protagonists. The variable part of the transfer is a decreasing function of Agent's coefficient of risk aversion r and an increasing function of the Principal's coefficient of risk aversion R. This means that a risk averse principal wants to sell the a larger part of the activity to the agentand let her bear the risk. To capture the price for the Principal of providing the water service we choose the total transfer given to the Agent.

$$C_L = t_L + w_L a_L = \frac{(1 + cr\sigma)(1 + c\sigma R)^2}{2c(1 + c\sigma(r + R))^2}$$

The corresponding expected utility of the Principal is

$$E[M_L] = 1 - exp\{-R[\frac{1 + c\sigma R - c^2 r\sigma^2 R}{2c(c\sigma R + cr\sigma + 1)}]\}$$

2.2 Syndicat, medium level of association

We introduce here the common agency problem with two identical Principals and one Agent. The following can easily be extend to n Principals. In this configuration the common agent has to provide effort for both principals. We have to take into account in our model the potential interactions of those actions. To do so we introduce a different cost function for the agent : $\frac{c}{2}(a_1^2 + a_2^2 + 2ka_1a_2)$. The sign of the crossing term k, where $k \in]-1, 1[$, gives the effect of joint production. Therefore if $k < 0$ the efforts are complements and if $k > 0$ the effort are substitutes. Complementary and substituability of efforts are key elements of common agency problems (see Martimort (1996) and Dixit (2002)).

2.2.1 Syndicat with public production mode

In public organization each Principal observes what the public common Agent does for her and for the other Mayor. These informations are contractable and both Principal condition their transfers to them[2]. Indeed we assume that each local government keep a special authority relationship with the common public agent making it possible to condition its payment to bothsignals. The utility functions in this framework are the following where w_{ij} is the variable transfer of Principal i for the observation in municipality j.

$$\begin{cases} M1_M^{Pub} = 1 - exp\{-R[x_1 - t_1 - w_{11}x_1 - w_{12}x_2]\} \\ M2_M^{Pub} = 1 - exp\{-R[x_2 - t_2 - w_{21}x_1 - w_{22}x_2]\} \\ U_M^{Pub} = 1 - exp\{-r[t_1 + t_2 + (w_{11} + w_{21})x_1 + (w_{12} + w_{22})x_2 - \frac{c}{2}(a_1^2 + a_2^2 + 2ka_1a_2)]\} \end{cases}$$

[2]The Mayors can not commit to not use all the available information. If a Mayor decides to not use the informative signal about the quality provided to her partner it is always in the best interest of the other Mayor to use the corresponding information. The Nash equilibrium is therefore an agreement where both Mayors use the signal associated to her partner.

The levels of effort selected by the Agent for each municipality are

$$ai_M^{Pub} = \frac{k(w_{jj} + w_{ij}) - (w_{ji} + w_{ii})}{ck^2 - c} \quad where\ i \neq j\ and\ i, j \in \{1, 2\}$$

Using the participation constraint we can derive an expression for the fix part of the transfer. We assume that this fix amount is equally shared by the Principals.

$$\begin{aligned} t1_M^{Pub} + t2_M^{Pub} = &- (w11_M^{Pub} + w21_M^{Pub})x_1 - (w22_M^{Pub} + w11_M^{Pub})x_2 + \frac{c}{2}a_1^2 \\ &+ \frac{c}{2}a_2^2 + kca_1a_2 + \frac{r}{2}(w11_M^{Pub} + w21_M^{Pub})^2\sigma + \frac{r}{2}(w12_M^{Pub} + w22_M^{Pub})^2\sigma \end{aligned}$$

The expression of the variable part we use takes into account the total amount percieved by the Agent in community 1, $w1_M^{Pub} = w11_M^{Pub} + w21_M^{Pub}$, and in community 2, $w2_M^{Pub} = w22_M^{Pub} + w12_M^{Pub}$.

$$wi_M^{Pub} = wii_M^{Pub} + wji_M^{Pub} = \frac{1 + (1 + k)c\sigma R}{1 + c\sigma(1 + k)(R + 2r)} \quad where\ i \neq j\ and\ i, j \in \{1, 2\}$$

Comparing these variable parts with the one of the low level of integration we see that if $k < 0$, if the efforts are complements, the variable part in a syndicat level under public supply tends to be higher. Yet the coefficient of risk aversion of the Agent is associated with a weight of 2. This comes from the fact that since each Principal condition her payment to two observations the Agent for one task faces risk two times. This mechanically decreases the amount of the variable part of the transfer. In fact the public mode of production makes it possible for the principal to use an other incentive tool, the other signal of quality, and diminishes the cost. Yet the other principal follows the same strategy and creates a negative exterbality.

2.2.2 Syndicat with private production mode

In a private organisation the Principal are not able to use a signal of the percieved quality in the other community, either because such a signal does not exist or because such a signal is not contractable. In contrast with what happens in apublic production mode the local government does not have a special authority on the common agent. The authority is equally shared by all the members of the association when it comes to the negociation with the private agent. The utility functions take then the form

$$\begin{cases} M1_M^{Priv} = 1 - exp\{-R[x_1 - t_1 - w_1x_1]\} \\ M2_M^{Priv} = 1 - exp\{-R[x_2 - t_2 - w_2x_2]\} \\ U_M^{Priv} = 1 - exp\{-r[t_1 + t_2 + w_1x_1 + w_2x_2 - \frac{c}{2}(a_1^2 + a_2^2 + 2ka_1a_2)]\} \end{cases}$$

The corresponding levels of effort selected by the common Agent are

$$ai_M^{Priv} = \frac{kw_j - w_i}{ck^2 - c} \quad where\ i \neq j\ and\ i, j \in \{1, 2\}$$

Finally the variable parts are identical for the two mayors

$$wi_M^{Priv} = \frac{1 + cR\sigma(1+k)}{1 + c\sigma(1+k)(r+R)} \quad \forall i \in \{1,2\}$$

The variable part in a syndicat under private supply is very similar to the one of the public supply case. The only difference is the weight associated to the Agent's risk aversion. Under private supply the risk supported by the Agent does not increase with the number of local governments. Therefore the only difference between the low integration level and this medium integration level is the scales effects.

2.3 Communauté de communes, high level of association

The last case we have to model is the highest level of association. This correspond to a configuration where local governements delegate the water service to a supra-entity the communauté de communes. They are not accountable for the quality of the service or for its cost. They do not interact with the Agent either. The supra-entity is directed by a Super-Principal or Super-Mayor in charge of the water service, she acts exactly as a regular Mayor and her utility function is noted SM.

$$SM = 1 - exp\{-R[X - T - w_{SM}X]\}$$

The Super-Mayor values $X = a_1 + a_2 + \epsilon$, where $E(\epsilon) = 0$ and $V(\epsilon) = \sigma$, the perceived quality. In the two communities case, the perceived quality is a single signal informative about the efforts made by the Agent in the two communities. Note that we do not use a different ϵ for this higher level of integration. This means that in our model the quality of the observation of a distant Super-Mayor is the same that the one of a closer observant. Intuitively we should face a different ϵ say ϵ_{SM} with a higher variance. Nevertheless we choose to keep the current ϵ to draw clearer comparisons and generate more easy to read results, the introduction of ϵ_{SM} does not change the quality of our results. Furthermore since the only relevant observation is X, there is no theoretical difference between a private and a public organization.
In the highest level of association a single Agent is in charge of the water service in several communities. Therefore she faces the same cost function as the one of the medium levels of integration, $\frac{c}{2}(a_1^2 + a_2^2 + 2ka_1a_2)$, where $k \in]-1,1[$. We can then derive the expected utilities of the Agent and the Super-Mayor.

$$\begin{cases} E[SM] = 1 - exp\{-R[(a_1+a_2)(1-w_{SM}) - T - \frac{1}{2}R\sigma(1-w_{SM})^2]\} \\ E[U_H] = 1 - exp\{-r[T + w(a_1+a_2) - \frac{c}{2}(a_1^2 + a_2^2 + 2ka_1a_2) - \frac{1}{2}rw_{SM}^2\sigma]\} \end{cases}$$

Following the same resolution path we find that

$$w_{SM} = \frac{2 + cR\sigma(1+k)}{2 + c\sigma(1+k)(r+R)}$$

Comparing this variable part with the one of the syndicat with a private production mode we see that when the number of communities managed by the Super-Mayor increases, the variable part increases. An increase of the number of communities crushes the negative effect induced by risk aversions. This effect is independent of the complementarity/substituability effect. We can present here on a single view the different variable parts.

	L	M	SM
Pub	$\frac{1+Rc\sigma}{1+c\sigma(r+R)}$	$\frac{1+(1+k)c\sigma R}{1+c\sigma(1+k)(R+2r)}$	$\frac{2+cR\sigma(1+k)}{2+c\sigma(1+k)(r+R)}$
Priv	$\frac{1+Rc\sigma}{1+c\sigma(r+R)}$	$\frac{1+cR\sigma(1+k)}{1+c\sigma(1+k)(r+R)}$	$\frac{2+cR\sigma(1+k)}{2+c\sigma(1+k)(r+R)}$

If it is the Super-Mayor responsibility to choose the level of quality and support the cost, it is the Mayor's privilege to choose the level of association. The interest of the highest level of association for a Mayor is to dilute her responsibility. Even if the Mayor is not accountable for the water service she gets spin off from the Super-Mayor activity.

$$E[M_i^H] = 1 - exp[-R[\frac{\lambda}{2}(\frac{2w_{SM}}{c(1+k)} - \frac{w_{SM}^2}{c(1+k)} - \frac{1}{2}rw_{SM}^2\sigma - \frac{1}{2}R\sigma(1-w_{SM})^2)]] \quad \forall i \in \{1,2\}$$

Each Principal will get the average of the net certainty equivalent of the Super-Mayor weighted by a coefficient λ, where $\lambda \in [0,1]$. This coefficient can be interpreted as the importance of the spin off, the amount of accountability left to the Mayor or as the reduction of the Mayor's risk aversion implied by the delegation of the water service. We choose this model to take into account the fact that the cost of water is the same for everyone in a municipal community[3].

2.4 Comparison of costs

We focus on the first-order conditions of the Principal's maximization programs to establish the marginal benefits and costs of the different strategies[4]. The first order condition associated to the low association level is the following

$$\underbrace{\frac{1+Rc\sigma}{c}}_{\text{marginal benefit}} - \underbrace{\frac{w}{c}}_{\text{marginal cost of effort}} - \underbrace{w\sigma(r+R)}_{\text{marginal cost of risk}} = 0$$

[3]Note that the other possible modelization will apply the coefficient λ not to the average certainty equivalent but to the quality observed in community i, the cost remaining equally shared among the Mayors. Such a model does not change the quality of our results and leads to a discussion on observability similar to the one regarding the choice between ϵ and ϵ_{SM} at the Super-Mayor level.

[4]Such a comparison strategy is used in Maier and Ottaviani

The main difference with the medium association level with a private mode of production consists complementarity/substituability effect.

$$\underbrace{\frac{1+Rc\sigma(1+k)}{c(1+k)}}_{\text{marginal benefit}} - \underbrace{\frac{w}{c(1+k)}}_{\text{marginal cost of effort}} - \underbrace{w\sigma(r+R)}_{\text{marginal cost of risk}} = 0$$

If $k < 0$ both the marginal benefit and the marginal cost are higher in a syndicat but the marginal cost of risk stay unchanged. It is then straightforward that with $k < 0$ the syndicat is selected. Comparaing the private and public mode of production in a syndicat.

$$\underbrace{\frac{1+Rc\sigma(1+k)}{c(1+k)}}_{\text{marginal benefit}} - \underbrace{\frac{w_{11}+w_{12}}{c(1+k)}}_{\text{marginal cost of effort}} - \underbrace{(w_{11}+w_{12})\sigma(2r+R)}_{\text{marginal cost of risk}} = 0$$

We see that the marginal benefits are identical. However, the marginal cost of effort and risk are different. In public organization the Principal is able to use two variables namely w_{11} and w_{12}. On one hand this makes it possible for the Principal to decrease her marginal costs. On the other hand the other Principal also use two variables and imposes negative externalities on the marginal cost of risk. Finally, the first order condition associated to the highest level of association (communauté de communes) is

$$\underbrace{\frac{\lambda(2+Rc\sigma(1+k))}{2c(1+k)}}_{\text{marginal benefit}} - \underbrace{\frac{\lambda w}{c(1+k)}}_{\text{marginal cost of effort}} - \underbrace{\frac{\lambda w\sigma(r+R)}{2}}_{\text{marginal cost of risk}} = 0$$

In this configuration the risk faced by the Principal is diluted and the marginal benefit and cost inceases with λ. It is not possible to determine a priori which level of association and modes of production is prefered. Nevertheless we can order the marginal costs with respect to the marginal benefit. Let Bm_i be the marginal benefit with association level i and Cm_i the corresponding marginal cost.

Proposition 1 *If* $Bm_M^{Priv} = Bm_M^{Pub} > Bm_L$ *and* $Bm_H > Bm_L$, *then* $Cm_M^{Priv} > Cm_M^{Pub} > Cm_H > Cm_L$

Note that it is possible to compare the total cost at the equilibrium of the public and private mode of production for a sundicat

Proposition 2 *Total cost with a private organization is higher than the total cost with a public-organization in an intercommunal association.*

$$C_M^{Priv} > C_M^{Pub}$$

2.5 Determinants of the Mayor's choice among integration levels and organization types

We will now study the determinants of the Principal's choice between the different levels of association andmodes of production. This choice depends on two dimensions namely the magnitude of the complementarity/substituability effect, k, and the responsibility left to the Mayor when the highest level of integration is selected, λ.
Focusing on k for the moment we are able to determine two thresholds in k. The results are summed up in the following proposition.

Proposition 3 *If* $1 < c^2\sigma^2(R^2 + 2rR)$ *(Condition 1)*[5] *there are some threshold values* $-1 < k_1 < 0$ *and* $0 < k_2 < 1$ *such that*

$$\begin{aligned} &E[M_M^{Priv}] \geq Max(E[M_M^{Pub}]; E[M_L]), \quad \forall k \in]-1, k_1] \\ &E[M_M^{Pub}] \geq Max(E[M_M^{Priv}]; E[M_L]), \quad \forall k \in]k_1, k_2] \\ &E[M_L] \geq Max(E[M_M^{Pub}]; E[M_M^{Priv}]), \quad \forall k \in]1, k_1] \end{aligned}$$

When there is complementarity of the efforts, $k < 0$, the Principal will choose to associate with other local governments under a syndicat or a communauté de commune. The choice between public and private mode is based on risk management. These results are depicted in the following graph.

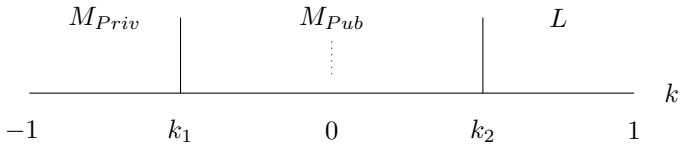

Fig. 1. Choice among L, M_priv, M_pub, H

We have determined the ranking of M_{Pub}, M_{Priv} and L with respect to k. We will now compare the best of these strategies with the highest level of association with respect to λ. To do that we build three threshold functions where $CE(M_i)$ is the certainty equivalent of strategy i.

$$\begin{cases} \lambda_1(k) = \frac{2CE(M_M^{Priv})}{CE(SM)} & \forall k \in]-1, 1[\\ \lambda_2(k) = \frac{2CE(M_M^{Pub})}{CE(SM)} & \forall k \in]-1, 1[\\ \lambda_3(k) = \frac{2CE(M_L)}{CE(SM)} & \forall k \in]-1, 1[\end{cases}$$

We can then write a new proposition based on the λ_i equivalent to *Proposition 1*

[5]Condition 1 guarantees that there is an interval $[k_1, k_2]$ in which the medium level of integration with a public organization is the best choice for the Principal. This condition is respected in configuration characterized by important cost and risk aversions; and low quality signal.

Proposition 4 *If* $1 < c^2\sigma^2(R^2 + 2rR)$ *(Condition 1) there are some threshold values* $-1 < k_1 < 0$ *and* $0 < k_2 < 1$ *such that*

$$\begin{aligned}
&\lambda_1(k) \geq Max(\lambda_2(k); \lambda_3(k)), \quad \forall k \in]-1, k_1] \\
&\lambda_2(k) \geq Max(\lambda_1(k); \lambda_3(k)), \quad \forall k \in]k_1, k_2] \\
&\lambda_3(k) \geq Max(\lambda_1(k); \lambda_2(k)), \quad \forall k \in]1, k_1]
\end{aligned}$$

Above these threshold functions the highest level of associatio is chosen. Under this threshold the choice of the Principal collapses to the one presented in proposition 1.

Proposition 5 *If* $1 < c^2\sigma^2(R^2 + 2rR)$ *(Condition 1) there are some threshold values* $-1 < k_1 < 0$ *and* $0 < k_2 < 1$ *such that*

$$\begin{aligned}
&If\ \lambda \geq \lambda_1(k)\ then\ E[M_H] \geq E[M_M^{Priv}]\ otherwise\ E[M_H] < E[M_M^{Priv}] \quad \forall k \in]-1, k_1] \\
&If\ \lambda \geq \lambda_2(k)\ then\ E[M_H] \geq E[M_M^{Pub}]\ otherwise\ E[M_H] < E[M_M^{Pub}] \quad \forall k \in]k_1, k_2] \\
&If\ \lambda \geq \lambda_3(k)\ then\ E[M_H] \geq E[M_L] \quad otherwise\ E[M_H] < E[M_L] \quad \forall k \in]k_2, 1[
\end{aligned}$$

When the responsibility left to the Mayor increases she will choose the highest level of association since this integrational form reduces the risk supported by her. These results are depicted in the following graph.

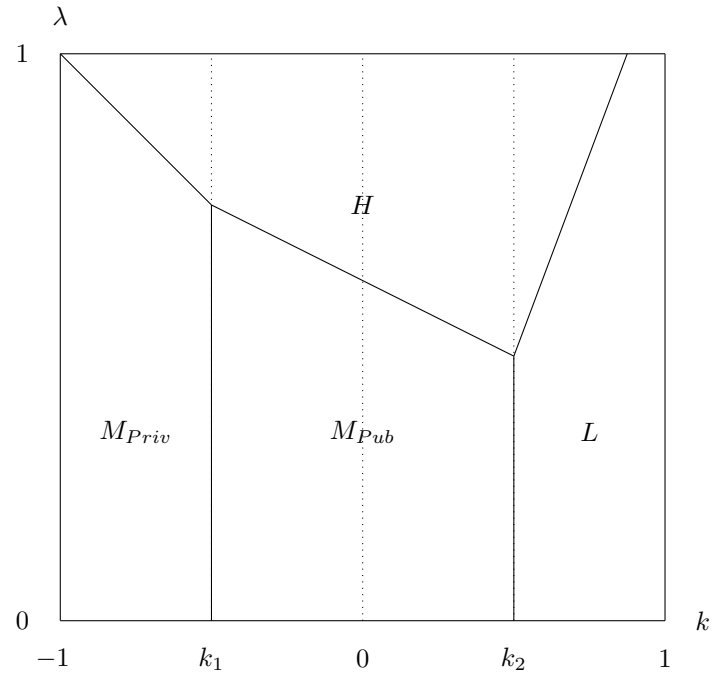

Fig. 2. Choice among organization types and integration levels

2.6 Discussion

Let us summarize the main prediction with the help of *Table i*. According to the theoretical model above, the nature of the principal matters. Precisely, the incentive faced by the mayor differ depending of the level of integration under consideration. We now turn to the empirical part of this paper.

3 Data and Empirical Strategy

In this paper we investigate whether the nature of the principal affects the overall performance of public services. The theoretical model exposed above considers three levels of integration namely low, medium and high across which public service can be produced in-house or through a private contract of public service delegation. To empirically test our theoretical assumptions we benefit from a data set on the French Water Industry. This balanced panel allows us to observe three levels of integration and their related performances over the time period 2008-2014. The next section exposes the French institutional background of water provision, describe our data set, and justify their joined relevance to test our theoretical assumptions.

3.1 Institutional background on the French Water Industry

The French political system is characterized by several levels of governance, where the lower, municipalities, is responsible for the provision of local public services as in most other European countries (Daniele and Vertier). Without any national regulation, they have to define the service, select the provider and monitor the performances. They also have to deal with two main choices: Will they regroup to manage the provision of public service ? Who should manage the service? The former question refers to the integration with other municipalities while the second refers to the make or buy decision between public or private provision.

3.1.1 The French water governance system: three levels of integration

Since 1800s, municipalities have set up the drinking water network and manage this as local monopolies. Since the 1900s, municipalities may also form an "intercommunal association" to coordinate themselves in a same network. For instance, some municipalities could have an interest to join this type of association to gain economy of scales. It's the reason why some municipalities have decided to integrate these associations to quickly set up the network in the 1950'. In 1999, an integrated mode of political organization was introduced ("Etablissements Publics de Coopération Intercommunale à fiscalité propre"). These "Community of Communes" are more integrated than the previous associations because they imply a transfer of the competency. Also, several munic-

ipalities have decided to transfer the competencies from the municipal to the Community.

Today, the network is achieved and the municipalities have only to manage the service and to renew the network. They have three modes of political organization:

- **Municipal management**: the municipality manages itself the water provision
- **Municipal cooperation**: the municipality joins an association to share some competencies
- **Municipal community**: the municipality transfers the competency

The municipalities therefore have a first choice to make: manage alone, manage with others or transfer. This choice is a political decision and there is no national regulation of the water provision. In 2016, there are 15.000 local public authorities. 71% are municipals; 27% are in association and only 2 % are in community. However, the municipals concern 39% of the population, associations cover 40% and the communities cover 21%.

We observe a continuum about the integration of the municipality, with a non-integrated form ; a semi-integrated form (association) and a integrated form (community). We assume that these different forms of political organizations are no neutrals for the principal type. In the first mode, the municipal is the unique principal to manage the contractual relationship and we can find a standard principal-agency relationship. In the semi-integrated form, we assume that the unique provider (local monopoly) contracts with a virtual unique structure because it represents each local interest of the cities. This situation is a common agency case with multi-principal concern. The last form is close to the unique principal form, but to transfer its competency, municipality have to receive a counterpart.

In France, each municipality chooses a mode of public organization for each public utility. Our theoretical model shows the main reasons why a municipality could select the "best" political organization. There is a trade-off between political responsibility and economies of scale. Higher is the integration and higher are the economies of scale and lower is the direct political responsibility for the mayor. Each mayor has to select the political form to manage the service. The political gains/risks associated to each type of mode of organization are not the sames. When the Mayor is the direct and unique authority of the provision, the benefits and the risks are not shared or transferred.

We can summarize the different characteristics associated to each mode of organization in France:

The main articles about French water industry don't take into account the different mode of political organizations. The literature and our model assume that the nature of the principal is related to the efficiency.

Table 1. Characteristics of the political forms of integration

Mode of political organization **Characteristics**	**Municipality**	**Cooperation** (semi-integrated)	**Community** (integrated)
Political responsibility of the mayor	++	+	-
Management power of the mayor	++	+	-
Risk raking of the mayor	++	+	-
Economies of scale	–	+	++

3.1.2 Two alternative modes for providing: to make or buy

Secondly, the public authority have to choose between making or buying the service. The water provision is a local monopoly with a unique provider. To provide this service, the public authority cans choose a direct public manager ("régie") and manage itself the providing of the water or she cans choose a private operator. In each case, the public authority is a local regulator and supervises the operator. If she chooses a private provider it will contract with it to determine the commercial terms of service (price, quality etc.). French law regulates little choice of the operator. The rules only impose a limit on the duration of the contract and force to restore competition to the end of contracts. In private management, infrastructures remain the property of the public authority.

The price of the water is the unique resource for the operator. Due to the principle "water pays water", the price paid by the users of water has to cover all the costs. French law prohibits any other resource than the price. That is why the price of water is considered a good signal management because it is supposed to reflect costs. The private operator must integrate its profit and coverage of costs in the price negotiated with the municipality. The empirical and theoretical literature has extensively studied the impact of management mode on the final price.The results are ambiguous and show that the public versus private differences are not obvious.

On the 15,000 local monopolies, 31 % are private and 71 % are public. However, private operators are covering 61 % of the population against 39 % for public operators. We denote that the structure of this industry is highly oligopolistic for the private provision. The private operators are mainly three on the market (Veolia, Suez and Saur).

3.1.3 The impact of these two choices on the price

So far, empirical studies have investigated the impact of management mode on price. We wish to empirically test our assumptions that the choice of organizational form of the public authority and the administration simultaneously

have an impact on price. Indeed, the form of political organization can impact the quality of monitoring and explain the public versus private differences. In their paper, Chong et al. (2015) show a public-private difference only for small services. However, they do not explain this difference. We believe that the implementation of political organization may also explain the price differences between private and public. That is why we consider it important not uniformly treat the public authorities.

Our theoretical model aims to show that the organizational form policy will impact on management. By implementing economies of scale issues, risk aversion and political preferences, we can also explain the motivations of public-private choice and its consequences on the final price.

The French case is a good field of application for our model. Indeed, it includes a continuum in the local political integration and differences in management. Furthermore, several reforms (called Law "MAPTAM" in 2014 and the law called "OUR" in 2015) promote the integration of municipalities. Our model would analyze the empirical impact of integration on the performance of public service. In other words, the integration does it improve the public service?

3.2 Data and Sample

3.2.1 The data sample

We benefit from an open source database collected by the national observatory of the French water providers (Observatoire de l'eau et des milieux aquatiques, ONEMA). This exhaustive national database gives information on the performance of the 13 467 French local contracts from 2008 to 2014. This project follows the previous non exhaustive database collected by the French Environment Institute (IFEN) and the French Health Ministry (DGS) on the periods 1998, 2001, 2004 and 2008, used in Chong et al. (2015). Although we have merged the different pools to obtain a unique panel data set, the original sample was unbalanced. Each unique local contract could include from 1 to several municipalities. The majority of the French providers have few inhabitants (only 8.5 % of the providers are more than 10 000 people), but the large contracts cover 70 % of the population. Finally, by dropping missing values, we obtain a sample with 3,700 unique providers which represents 21 millions of French inhabitants (1/3 of the National population) and covers 9376 municipalities (26% of the total municipalities).

3.2.2 Dependent Variables

Our main dependent variable is the final price of water payed by the consumers. The French price of drinking water is the sum of a fixed part, a variable part and the different taxes. In our database, we use an official standardized price

for a 120 cubic meter consumption. The dependent variable is expressed in € by cubic meter.

The other dependent variable (named DELTAPRICE) used in our models is the difference between the observed price and the predicted price. This variable measures the distance between the computed optimal price and the observed price as described bellow.

Figure 3 shows the normal distribution of our the main dependent variable, the price including taxes per cubic meter.

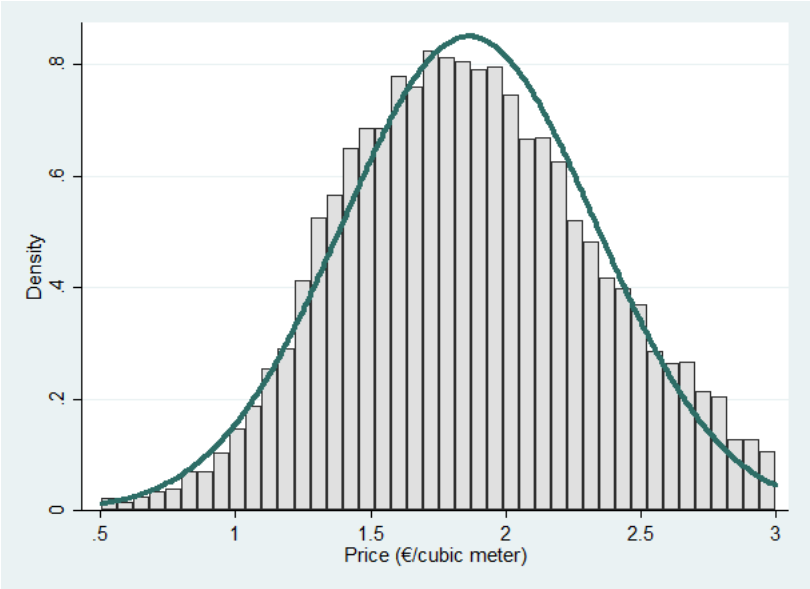

Fig. 3. Distribution of the dependent variable (Price)

In appendix we reports distributions for this variable according to the three different organizational forms.

3.2.3 Independent Variable

We select a set of control variables to explain the price of water in France. We follow the main control variables selected by Chong et al. (2015). Firstly, the origin of the water (groundwater or not) could be related to the price because the methods to product the water are different according to its origin. The Network performance and organic/chemical conformity show the quality of the water. The number of municipalities gives the concentration in the district. The population (logged) indicates the size of the provider. We have also three levels of treatment (A1, A2 and A3) which they are highly related to the costs.

We have built two sets of categorical variables. The first is related to the level of integration:
Municipal=1 if there is an unique municipality;
Cooperation=1 if there is an association of municipalities;
Integration=1 if there is a "super-municipality"

The second set of categorical variables refer to the provider. If "Private"=1, this is a private provider (if =0, it's a public provider).

Table 2. Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Price	1.864	0.469	0.505	2.999	18596
Share of groundwater	87.581	31.578	0	100	18596
Network Performance	75.688	13.851	0	100	17315
Organic Conformity	96.912	9.374	0	100	18231
Chemical Conformity	96.710	12.761	0	100	18187
Number of municipalities	4.872	15.173	1	565	18587
Log population	7.425	1.722	2.398	15.255	18588
Treatment A1	0.809	0.377	0	1	13377
Treatment A2	0.102	0.29	0	1	13377
Treatment A2	0.064	0.233	0	1	13377
private	0.422	0.494	0	1	18596
Municipal	0.579	0.494	0	1	18596
Cooperation	0.358	0.479	0	1	18596
Integration	0.063	0.243	0	1	18596
Year	2011.415	1.840	2008	2014	18596

3.3 Specification

The empirical work is partly concerned with testing specific hypotheses previously exposed, but also to establish empirical regularities. We therefore adopt a relatively standard empirical specification describing policy outcomes:

$$y_{it} = \alpha + \eta_k z_{i,k,t} + \beta_j u_{i,j,t} + v_i + \mu_t + \epsilon_{it} \tag{1}$$

Here, y_{it} denotes a policy outcome in the service i and year t. The specification allows for a potential individual-specific component v_i discussed below, as well as for a year fixed-effect μ_t.

Price can be affected directly by the organizational form $z_{i,k,t}$, concretely by the value of one of the three dummies variables Municipality, Association, Community of service i at time t interacted with an in-house vs private dummy variable. $u_{i,j,t}$ is a vector of idiosyncratic technical variables and ϵ_{it} is a random error term.

Given (1), we pose the question of a systematic effect from organizational form to policy outcome. In others words we test the following null hypothesis:

$$H_0^D : \eta_j = 0,$$

i.e., the absence of a direct effect of the organizational form on the price structure. In particular, the estimate of η_j should correspond to the average effect on the policy outcome, when the water service is organized as j, i.e. one of the six combinations exposed above. Most of the theory discussed in Section 2 was really about such direct effect. This question is particularly relevant in our case study since water provision is supposed to be base on 'the water pays for water' principle. The overall performance of the service i at time t should be, then, only determined by its idiosyncratic technical characteristics $u_{i,j,t}$.

3.4 Empirical Strategy and identification

In a first specification we estimate equation (1) in order to test for the impact of organization form of the principal on the water price. When one wants to explore the relationship between municipalities' organizational form and performance, issues of endogeneity have to be discussed. As exposed by Chong et al. (2015), "it is possible that the topology of a municipality may influence the cost of water provision, and may systematically drive a municipality to favor one organizational mode" (p. 12). As suggested by the authors, such issue can be addressed using the panel dimension of the data set as long as any heterogeneity that lead a municipality to favor an organization form is time-invariant (Hamilton and Nickerson 2003). We then use a random effect approach to estimate whether organizational design has an impact on the performance of the water supply. First, the price of water is explained by a set of invariant variables such as the regional water agencies or the chemical treatments. Second our data set can be assimilated to a random sample from a much larger universe of services.

In a second specification, we explore the impact of organizational forms on the overall performance of public services, and then need to identify instances of overpricing. We follow the approach of Nickerson and Silverman (2003) and Chong et al. (2015) by first estimating a linear model of water price. Precisely, we assume that H_0^D is true, i.e. that organizational form has no effect on the price estimated. We then estimate a first model to generate an 'expected price for each service' without including any political variable, that is, the price that the linear model predicts for that service given the technical service's characteristics in a given year t, as supposed by the 'water pays for water' assumption. The difference between the observed price and the estimated prices obtained represents the degree of overpricing (or underpricing) of water in services as of year t (Chong et al., 2015). We use this measure of performance as dependent variable in a new specification where organizational forms are the only independent regressors.

$$Y_{it} = \alpha + \eta_k Z_{i,k,t} + v_i + \mu_t + \epsilon_{it}, \tag{2}$$

$$where \;\; Y_{it} = \frac{Price_{it} - y_{it}}{Price_{it}} \tag{3}$$

Where Y_{it} are pointed estimated in equation (1) and $Price_{it}$ the observed price of service i at time t. If $Y_{it} > 0$ the provision of water is overpriced given the technical characteristics of the service.

4 Results

4.1 Basic Specification: organizational forms and service price

Table 3 presents results for our first specification. We consider two different approaches defined in Section 3.3 by testing whether the organizational form of the water provision (the principal) does have an impact on the price support by customers. Column (1) reports estimation for the case where only technical components and the size of the population would matter following the "water pays for water". In such a design, the share of groundwater as well as the size of the population and the number of municipalities in the network are the main drivers of the final price paid by households. A 1% increase in the share of groundwater decreases by 0.0005 euro per cubic meter the price of tap water. This is mainly due to the purity of groundwater which necessitates less treatments. Conversely, one more municipality in the network increase the price by 0.007 euro by cubic meter, which reflects the complexity of the system. Similarly, a 1% increase of the population leads to increase the price of water by 0.0198 euro per cubic mater. Treatments are also drivers of first importance of the cost and are included in all our specifications as dummies variables (A1, A2 and A3). Details results of treatments' coefficient are presented in appendix, Table 6. The points estimated in column (1) are employed to estimate equation (3).

Column (2)-(4) present result when we include the organizational forms of the services, namely Municipal (low), Cooperation (medium), and Integration (high), and a dummy 'make or buy' variable, namely Private. Our results strongly support that the form of the principal matters as determinant of the price. In line with Chong et al. (2015), we find that the price from private operators is at least 0.25 euro per cubic meter more expensive than in-house operators. Additionally, our results reports a strong impact from the organizational form of the service. The Cooperation (medium level) is more expensive than the two others forms by 0.17 euro per cubic meter on average while the Municipal form of management is less expensive by 0.177 euro per cubic meter on average, and integration by 0.0203 euro per cubic meter.

These results confirm that the organizational form of public services are non-neutral on the final price support by households. We also report a couple of others estimates following this first specification in appendix which support the results from Table 4. While these first investigation are quite interesting and provide new evidences of the impact of the managerial form of public services provision, we do not deal with "efficiency". The section below focuses on this issue.

4.2 Extended specifications: organizational forms and efficiency of the provision

The estimates from equation (2) are reported in Table 5. The dependent variable is calculated from equation (3) and corresponds to the efficiency of the service i at time t given its technical characteristics. Column (1) to (3) confirm that public service delegation to a private operator increases the price from at least 0.133 euro per cubic meter. More interesting, the result show a substantial correlation between organizational forms and performance of the service: Municipal over-performs, Cooperation under-performs and Integration does not report significant impact. When we consider the interaction between organizational forms and private provision, Cooperation is the less efficient form of management.

Table 3. Summary of the empirical results

	DeltaPrice	**DeltaPrice * Private**	**DeltaPrice * Private * Size**
Municipal	- -	No impact	No impact
Cooperation	++	+	No impact
Integration	0	No impact	Yes for the small communities (–)

Table 4. Basic Specification - Organizational Forms

VARIABLES	(1) Price	(2) Price	(3) Price	(4) Price
Share of Groundwater	-0.000503***	-0.000575***	-0.000579***	-0.000547***
	(0.000178)	(0.000175)	(0.000175)	(0.000176)
Network Performance	0.000382	0.000156	0.000163	0.000165
	(0.000238)	(0.000237)	(0.000237)	(0.000237)
Organic Conformity	4.68e-08	-0.000140	-0.000152	-0.000132
	(0.000356)	(0.000351)	(0.000351)	(0.000352)
Chemical Conformity	0.000430	0.000422	0.000431	0.000423
	(0.000375)	(0.000371)	(0.000370)	(0.000372)
Number of municipalities	0.00748***	0.00448***	0.00462***	0.00781***
	(0.00126)	(0.00109)	(0.00110)	(0.00129)
Log Pop	0.0198***	-0.0204***	-0.0144***	-0.00567
	(0.00517)	(0.00493)	(0.00486)	(0.00524)
Private		0.251***	0.250***	0.261***
		(0.0152)	(0.0152)	(0.0158)
Municipal		-0.177***		
		(0.0176)		
Cooperation			0.170***	
			(0.0161)	
Integration				-0.0203
				(0.0227)
Constant	1.284***	1.684***	1.475***	1.451***
	(0.0767)	(0.0776)	(0.0751)	(0.0761)
Observations	12,390	12,390	12,390	12,390
Number of services	4,012	4,012	4,012	4,012
Individual RE	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
Water Agency Dummies	YES	YES	YES	YES
Treatment Dummies	YES	YES	YES	YES
p-value F-test model	,	,	,	,

Note: Robust standard errors in parentheses, *** significance at the 1% level, ** significance at the 5% level, *significance at the 10% level.

[a] F-test is an F-test of the null hypothesis that there is no joint effect of the chosen control variables

[b] F-test is an F-test of the null hypothesis that there is no joint effect of the chosen variables of interest

Table 5. Overperformance - Random Effect

VARIABLES	(1) Deltaprice	(2) Deltaprice	(3) Deltaprice
Private	0.209***	0.133***	0.192***
	(0.0284)	(0.0382)	(0.0236)
Municipal	-0.0973**		
	(0.0391)		
Cooperation		0.0958**	
		(0.0413)	
Integration			-0.0110
			(0.0738)
Municipal#Private	-0.0763		
	(0.0490)		
Cooperation#Private		0.0927*	
		(0.0493)	
Integration#Private			-0.0392
			(0.0763)
Municipal#Private#Pop5000	0.0848		
	(0.0558)		
Municipal#Private#Pop10000	0.0458		
	(0.0644)		
Cooperation#Private#Pop5000		-0.0784	
		(0.0549)	
Cooperation#Private#Pop10000		-0.0199	
		(0.0603)	
Integration#Private#Pop5000			-0.207***
			(0.0791)
Integration#Private#Pop10000			-0.0336
			(0.0979)
Observations	12,390	12,390	12,390
Number of Service	4,012	4,012	4,012
Individual RE	YES	YES	YES
Year Dummies	YES	YES	YES
p-value F-test[a] control	(0.0000)	(0.0000)	(0.0000)
p-value F-test[b] organizational	-	(0.0000)	(0.0000)

Note: Robust standard errors clustered at service level in parentheses. *** significance at the 1% level, ** significance at the 5% level, *significance at the 10% level.

[a] F-test is an F-test of the null hypothesis that there is no joint effect of the chosen control variables

[b] F-test is an F-test of the null hypothesis that there is no joint effect of the chosen variables of interest

5 Discussion and Conclusion

5.1 Discussion on the benchmark

First, the theoretical model enables a ranking of efficiency between the different levels of integration. Empirically, we find some of these theoretical results. The single municipal appears more effective than all other forms of integration. The reason for this over performance lies in the interest of the mayor for the provision of public utility and political sensitivity. Indeed, the mayor is directly responsible for the success or failure of public service. It therefore has an interest in the supply to be effective in the price paid by users is the lowest possible. The cooperative form (medium integration) is the least efficient. Partial integration is characteristic of a common agency and generates additional costs that are empirically observed. Finally, the integrated form (high integration) appears as a true "super-municipality" led by a "super mayor". Although political accountability is low, economies of scale help to reduce the price. That is why the classification of theoretical final cost is identical to the empirical classification: Municipal Price $<$ Integration Price $<$ Cooperation Price.

So economy of scale effect seems weaker than the political responsibility effect. For a public utility is well managed, it is necessary that the elected directly responsible. In France, the mayor is elected closer to the citizens. Therefore it is logical that a municipal policy management more than shared or transferred management. In terms of public policy recommendation, we can suggest that the municipal groupings are ineffective if they are not linked to strong political responsibility. In this case, the public manager will have no incentive to get involved in the supervision of the service.

Second, by combining integration and type of provision we find some of the theoretical results. For the municipal form, there is no difference between the public management versus private management. Indeed, to the mayor, it will be equivalent to oversee a public or private provider as its political responsibility is the same. In addition, there is no size effect. In the integrated form, we partially find the theoretical result. In large integrated forms, public-private differences disappear. In smaller cooperation, the difference reappears. We explain this difference with the theoretical model that the assumption made on the integrated form is that the mayor is not more involved in the decisions after the transfer. But in small communities, integrated form would be more comparable to a cooperation that perfect integration. This situation would highlight the public-private difference. Finally, on cooperation, it seems most expensive privately and publicly. The explanation is given by the theoretical model by the quality of management in common agency.

These results help refine those found by Chong et al. 2015. The public-private difference disappears when considering the level of integration seems to be the main driver of the performance of a public service. In other words,

the public-private benchmark, it is important not to focus only on the identity of the supplier but to watch the nature of the principal. Organizational choices suggest that the performance of a public service depends primarily on the quality of supervision. Over the supervisor is directly responsible policy and overseeing the monopoly will be efficient. Conversely, communities' groupings lead to politically disempowering mayors and reduce the quality of supervision. In terms of cost, the union does not seem to force. The argument therefore economies of scale seem rather questionable against the supervision of challenge and responsibility.

5.2 Discussion on the choices of the Mayors

TBA.

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6 Appendix

6.1 Expected utility functions of the local government

$$E[M_L] = E[1 - exp\{-R[x - t - wx]\}]$$

$$E[M_L] = 1 - E[exp\{-Rx(1 - w) + Rt\}]$$

$$E[M_L] = 1 - exp\{E[-Rx(1 - w) + Rt] + \frac{1}{2}Var[-Rx(1 - w) + Rt]\}$$

$$E[M_L] = 1 - exp\{-Ra(1 - w) + Rt + \frac{1}{2}R^2(1 - w)^2\sigma\}$$

$$E[M_L] = 1 - exp\{-R[a(1 - w) - t - \frac{1}{2}R(1 - w)^2\sigma]\}$$

6.2 Tables

Table 6. Naïve regression - Standard Controls

VARIABLES	(1) Price	(2) Price	(3) Price
Share of Groundwater	-0.00113***	-0.00103***	-0.00127***
	(0.000246)	(0.000234)	(0.000217)
Network Performance	0.000766	0.000451	-0.00138***
	(0.000470)	(0.000464)	(0.000443)
Organic Conformity	0.00396***	0.00355***	0.00158**
	(0.000667)	(0.000670)	(0.000619)
Chemical Conformity	-0.000361	-0.000320	-0.000588
	(0.000522)	(0.000516)	(0.000489)
Number of municipalities	0.00916***	0.00406***	0.00527***
	(0.00143)	(0.00107)	(0.00119)
Log Pop	-0.00275	-0.0179***	-0.0345***
	(0.00582)	(0.00552)	(0.00543)
Treatment A1[d]	0.111**	0.109**	0.0309
	(0.0538)	(0.0545)	(0.0536)
Treatment A2[d]	0.246***	0.212***	0.127**
	(0.0590)	(0.0597)	(0.0583)
Treatment A3[d]	0.306***	0.296***	0.200***
	(0.0623)	(0.0619)	(0.0597)
Constant	1.428***	1.633***	1.904***
	(0.0990)	(0.106)	(0.104)
Observations	12,390	12,390	12,390
R-squared	0.083	0.143	0.251
Water Agency Dummies	NO	YES	YES
Year Dummies	NO	NO	YES
p-value F-test[a]	(0,0000)	(0.0000)	(0.0000)

Note: Robust standard errors in parentheses. *** significance at the 1% level, ** significance at the 5% level, *significance at the 10% level.

[a] F-test is an F-test of the null hypothesis that there is no joint effect of the chosen control variables

[d] Treatment are dummy variables whose coefficients are not reported in others specifications but indicated as *Treatment dummies "YES"* if included.

Table 7. Naïve regression - Organizational Forms

VARIABLES	(1) Price	(2) Price	(3) Price
Share of Groundwater	-0.000855***	-0.00106***	-0.00127***
	(0.000250)	(0.000234)	(0.000217)
Network Performance	0.000347	0.000271	-0.00138***
	(0.000472)	(0.000463)	(0.000443)
Organic Conformity	0.00393***	0.00349***	0.00158**
	(0.000676)	(0.000675)	(0.000619)
Chemical Conformity	-0.000424	-0.000379	-0.000588
	(0.000521)	(0.000507)	(0.000489)
Number of municipalities	0.00908***	0.00394***	0.00527***
	(0.00143)	(0.00107)	(0.00119)
log Pop	0.000985	-0.0120**	-0.0345***
	(0.00589)	(0.00555)	(0.00543)
Municipal		-0.114***	-0.113***
		(0.0315)	(0.0313)
Cooperation		0.128***	0.0834***
		(0.0300)	(0.0297)
Private			0.308***
			(0.0144)
Constant	1.298***	1.475***	1.904***
	(0.103)	(0.108)	(0.104)
Observations	12,390	12,390	12,390
R-squared	0.113	0.159	0.251
Year Dummies	YES	YES	YES
Water Agency Dummies	YES	YES	YES
Treatment Dummies	YES	YES	YES
p-value F-test[a] control	(0.0000)	(0.0000)	(0.0000)
p-value F-test[b] organizational	-	(0.0000)	(0.0000)

Note: Robust standard errors in parentheses, *** significance at the 1% level, ** significance at the 5% level, *significance at the 10% level.

[a] F-test is an F-test of the null hypothesis that there is no joint effect of the chosen control variables

[b] F-test is an F-test of the null hypothesis that there is no joint effect of the chosen variables of interest

6.3 Distribution of the dependent variables

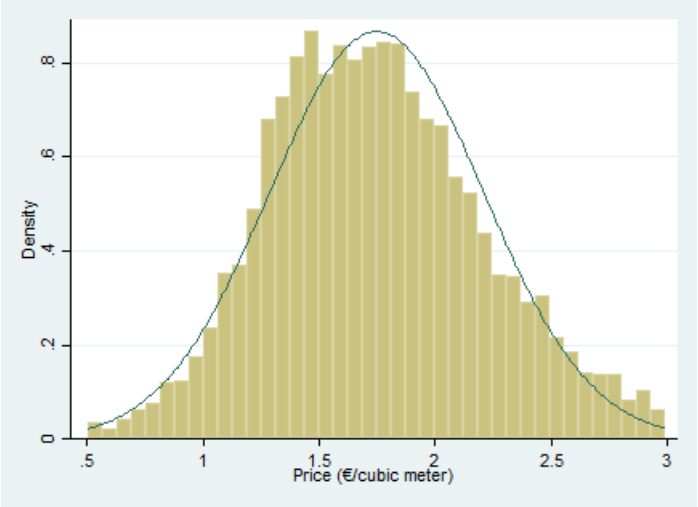

Fig. 4. Distribution of the dependent variable (Price) for Municipals

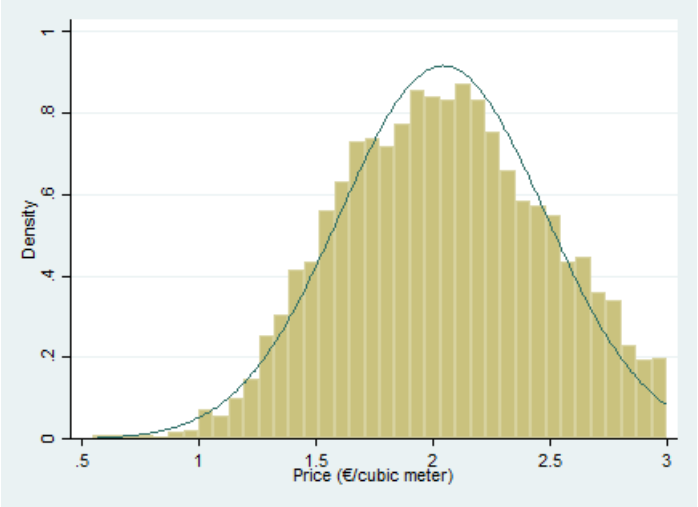

Fig. 5. Distribution of the dependent variable (Price) for Cooperations

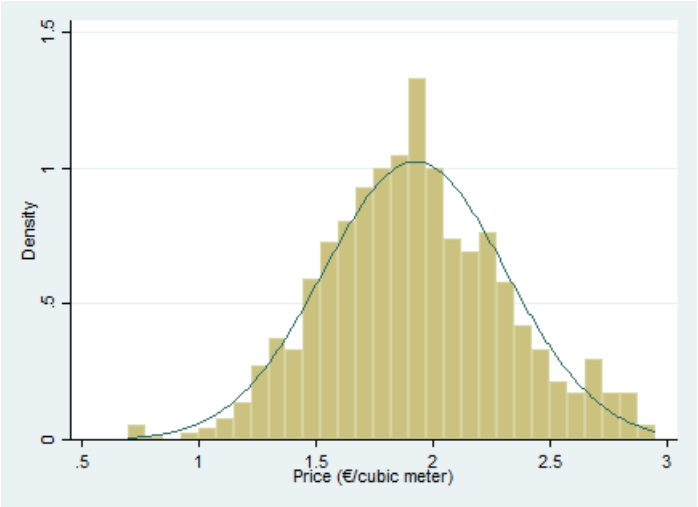

Fig. 6. Distribution of the dependent variable (Price) for Integrations

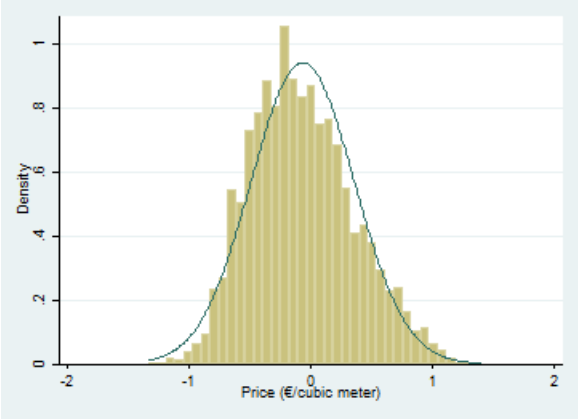

Fig. 7. Distribution of the dependent variable (DELTAPRICE) for municipals

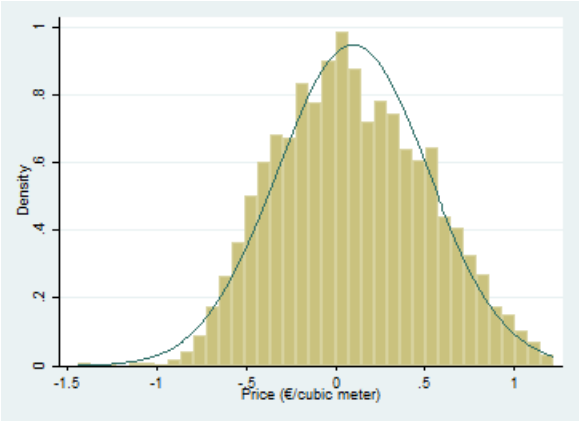

Fig. 8. Distribution of the dependent variable (DELTAPRICE) for Cooperations

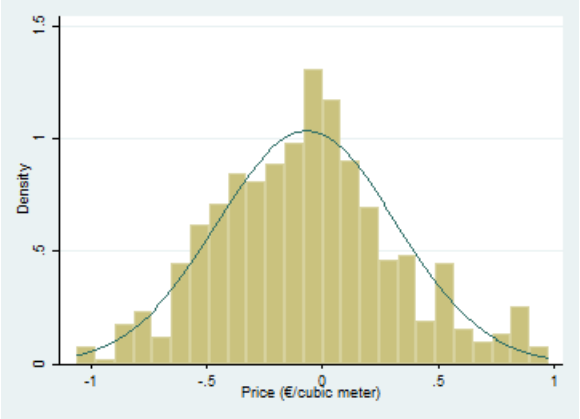

Fig. 9. Distribution of the dependent variable (DELTAPRICE) for Integrations