

Criticality of Assets and Organisational Centralisation: Evidence from French Drinking Water Services¹

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Abstract

The recent literature on the alignment of institutions and technology in network industries considers infrastructures as large technical systems. As such, in order to safeguard infrastructure performance, their technical integrity must be guaranteed. Core transactions, i.e. transactions involving highly specific and critical assets, therefore need to be aligned with suitable modes of organisation. Certain types of Public-Private Partnerships involve the decentralisation of decision-rights on critical assets, i.e. the splitting of decision-rights between the public party and its private partner. This can lead to high coordination costs. The result of an econometric test applied to French drinking water services supports the idea that increasing criticality of assets is linked to modes of organisation where decision-rights on these assets are highly centralised. As a policy implication, local authorities should not only think in terms of public or private provision of water services, but also in terms of distribution of decision-rights and possible coordination problems, especially in lease contracts and if their knowledge of the underground network is low.

Key words: Alignment, decentralisation, decision-rights, modes of organisation, coordination, transaction costs, Public-Private Partnership, water services, asset criticality, infrastructure

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Introduction

This paper studies the link between critical assets and organisational centralisation. More precisely, we analyse the link between a higher need for critical assets in the provision of drinking water services and the probability of observing modes of organisation with highly centralised decision-rights on these assets. We offer an econometric test of this idea applied to the French case. The reasoning is close to the make-or-buy question in transaction costs economics and to the role of asset specificity for vertical integration (Coase, 1937, Williamson, 1985, Joskow, 1988). According to this strand of literature, the presence of specific assets in association with uncertainty increases transactions costs. This is why modes of organisation will tend towards integration or long-term contracts, which provide more suitable coordination mechanisms like authority or contractual instruments to reduce such costs. This paper borrows from these ideas but considers several of their aspects from a different perspective. These differences arise out of the proximity of the argumentation with a new strand of literature, namely the literature on the alignment between technological characteristics and institutional arrangements in network industries (Finger et al., 2005, Ménard, 2009, Künneke et al., 2010, Crettenand and Finger, 2013). Substantively, attention must be given to three points.

Firstly, this paper considers infrastructures as large technical systems, thus stressing the importance of technology. Infrastructures consist of various strongly complementary technical components. An example of such complementarity can be given by water distribution networks which combine pipes, pumps, valves and more. The technical integrity of the overall system must be secured so as not to endanger the functioning of the service (Künneke et al., 2010, p. 495). This consideration of technology is missing in the traditional make-or-buy literature.

Secondly, whereas the literature on vertical integration underlines the decisive role of asset specificity in the choice of modes of organisation (Riordan and Williamson, 1985), emphasis here is placed on so-called critical assets (Künneke et al., 2010, p. 496). In doing so, the fundamentality and indispensability of these assets for the technical integrity of the system is underlined. In the distribution of drinking water, one might think of pipes. The underground transmission and distribution networks are particularly critical to the provision of drinking water services. They will also form part of the focus of this paper.

Thirdly, this paper does not ask whether water services should be provided through public or private management in order to perform well as in the classical make-or-buy literature. This is justified in the light of recent indications that ownership might not be the key issue for infrastructure performance (Ménard and Peeroo, 2011, p. 321). Rather, the focus lies on the (de-)centralisation of decision-rights on critical assets, and more particularly, the analysis of whether these decision-rights are concentrated in a single organisation or dispersed, i.e. distributed among the entities constituting a Public-Private Partnership (PPP). This approach

highlights potential coordination problems resulting from the splitting and sharing of decision-rights (Ménard, 2013, pp. 149 f., 163 f.). The question is therefore in what cases do decision-rights need to be centralised and when can they be more decentralised?

Although the still very young literature on the alignment framework has already brought forward a considerable amount of empirical analyses, namely in the form of case studies (Künneke and Finger, 2007, Crettenand, 2012, Perennes, 2015, Scholten, 2013), no econometric test has been proposed until now. In fact, the mainly qualitative nature of the framework has been identified as a weakness and the need for more quantitative measurement has been expressed (Crettenand and Finger, 2013, p. 125). It is hoped that this first attempt will contribute to the development of further ideas in order to promote the operationalisation of the alignment framework in the economic literature on infrastructures.

This paper is structured as follows. The next section introduces the alignment framework and defines several key concepts such as core transactions. These core transactions involve critical assets and need to be aligned with suitable modes of organisation in order to guarantee the technical reliability of the infrastructure. Thereafter, the paper's approach to the decentralisation of the decision-rights is elaborated upon, together with a proposed explanation of the ensuing coordination problems. A proposition is put forward according to which the existence of critical assets calls for more organisational centralisation. A section on the methodology then presents the data set for the French drinking water sector and the econometrical model. Variables are defined in order to measure the degree of decentralisation of modes of organisation and the criticality of assets. The results of the econometric test are then discussed in the following section. Support is provided for the initial idea that the criticality of assets might be a determinant of the degree of centralisation in the chosen mode of organisation. The final section concludes and also proposes possible extensions of this work.

The alignment framework

The founding article of the alignment framework (Finger et al., 2005) originates from the observation that reform of network industries has been mainly considered a question of institutional change only, ignoring the fact that infrastructures are large technical systems. According to the authors, this omission explains system failures like electricity blackouts or railway accidents experienced during the reform process. Despite the neglect of technical requirements by policy-makers and regulators, society has expectations with regard to the technical functioning of infrastructures and their performance (Künneke et al., 2010, p. 496). The expectations for drinking water services are to provide safe and clean drinking water with adequate pressure at any time to all users connected to the network.

Critical assets play a crucial role in assuring that these technical expectations are met (ibid.). Moteff et al. (2003) stress the essentiality of such assets for the entire system. This paper defines critical assets as those assets that are fundamental and indispensable to the technical functioning of infrastructures². In the drinking water sector, examples of critical assets are pumping stations, water treatment plants and the transmission and distribution pipelines.

Critical assets support core transactions. Ménard (2009, p. 89) defines core transactions as being “[...] essential to maintain the integrity of technical functions while keeping the system economically viable”. For instance, a main pipe is a critical asset that supports the core transaction of transporting drinking water. By contrast, peripheral transactions, like metering or refurbishing the building where the water service has its physical seat, are not critical for the technical integrity of the system³.

Guaranteeing the system’s technical integrity requires a tight coordination of core transactions (ibid., p. 108). The transportation of drinking water through pipelines for example involves a variety of processes and actions like gaining knowledge of the network’s state so that to repair or replace where necessary in order to prevent contamination of drinking water by bacteria or chemicals through leaks. It also requires sequencing: identification of leaks needs to be scheduled preceding, not following, repair works. Repair works need to be planned and sequenced as well so as to ensure the least disruption of service and road traffic possible.

All the activities surrounding core transactions require coordination. The transaction cost literature explains that different modes of organisation involve different coordination mechanisms (Coase, 1937, Williamson, 1985, Joskow, 1988). An integrated firm uses authority to coordinate. A hybrid mode of organisation, i.e. any form standing between integrated firms and markets (Ménard, 2004, p. 345), uses contracts. Usually, organising water services ranges from public management to full privatisation⁴ with various types of Public-Private Partnerships (PPPs) in between.

The coordination of core transactions through matching modes of organisation is the focal point of the alignment framework. When the technological characteristics of an infrastructure are aligned with matching modes of organisation, critical assets can fulfil their role in supporting core transactions in a way as to meet technical expectations linked to the delivery of clean drinking water (Künneke and Finger, 2007, p. 327). Misalignment lowers infrastructure performance (Künneke et al., 2010, p. 504). This paper looks at the distribution of decision-

² Critical assets are also specific assets, i.e. assets that derive their value from a particular use, which indicates the closeness of the issues discussed here to the make-or-buy literature.

³ It can be noted that criticality increases with time. Collecting water fees is not critical in the short-run, but a utility that finances its services through tariffs will need to collect eventually.

⁴ This option is in fact very rare in the water sector and has no significance in France. Examples are England and Wales or Chile.

rights across entities involved in the provision of water services to analyse the alignment problem. The question is whether the party who carries out core transactions is also the party who holds the decision-rights on the related critical assets.

According to Baker et al. (2008), each mode of organisation has a way to allocate decision-rights, some of which are transferable by contract. In order to study the intra-organisational allocation of decision-rights, we follow Boyer et al. (2001, pp. 4 ff.) who break down water services into various domains of action. These are finance, planning and design, construction, renovation (i.e. long-term investments), maintenance (i.e. short-term investments), operation of the infrastructure, and collecting and billing.

If all decision-rights are held by one party, corresponding to full public management or full privatisation, no intra-organisational coordination issues arise. Decision-rights are centralised in one hand. However, as soon as another party gets involved in the above listed activities, decision-rights are split between parties and are hence decentralised. Intra-organisational coordination is required. Such coordination is costly. Gulati and Singh (1998, p. 781) define these coordination costs as “[...] the anticipated organizational complexity of decomposing tasks among partners along with ongoing coordination of activities to be completed jointly or individually across organizational boundaries and the related extent of communication and decisions that would be necessary”. More complex transactions and higher asset specificity increase coordination costs (Ménard, 2004, p. 350). In analogy, core transactions involving critical assets also increase coordination costs. Let us consider the example of distribution pipelines needing replacement. Distribution pipelines are critical assets because they are crucial for the core transaction of transporting drinking water. In our example, their criticality is further increased by their desolate state jeopardising this core transaction and hence requiring urgent attention. Furthermore, their renewal constitutes another core transaction which is needed to ensure that the infrastructure fulfils its role. Under direct public management, the public party solely holds all decision-rights related to investments, including to replace pipes, and operation. The decision-rights are centralised. No intra-organisational coordination issues arise. In contrast, a lease contract, the most common form of PPP in France, entails the splitting of decision-rights on pipelines. The private party operates and maintains the network and gains knowledge about its condition, but is not responsible for the renewal of desolate parts of the network. This remains the responsibility of the local authority, who is dependent on the private operator to obtain the necessary information to efficiently carry out the core transaction of renewing ailing pipes. In that sense, there is a misalignment between the core transaction of renewal and the mode of organisation governing this transaction, the lease contract.

This lack of alignment therefore requires tight coordination between the contracting partners. Different types of coordination costs arise. *Ex ante*, the contract must include clauses that govern the dialogue between the parties and stipulate the transmission of information from the private operator to the local authority. *Ex post*, the local authority needs to direct and control the transmission of information. Because the *ex ante* distribution of decision-rights is not always clear in the contract, renegotiations at later stages are common (Ménard and Peeroo, 2011, p. 322).

It is apparent that the resulting coordination costs in the presence of critical assets might be very high in lease contracts. In other words, the need for investment in critical assets in combination with a mode of organisation where decision-rights on these assets are split across the local authority and the private operator might result in very high coordination costs. Where investments in critical assets are needed, the public authority might prefer to choose a mode of organisation where decision-rights on these critical assets are more centralised in order to economise these coordination costs. Ménard (2004, pp. 355 ff.) notes on that point that such coordination costs can be economised by replacing contractual agreements with quasi-integrated solutions. As a consequence, the degree of centralisation required to coordinate partners determines the chosen mode of organisation. This is why we expect to find higher centralisation of decision-rights in water services with a higher need for critical assets. These considerations lead to the formulation of the following **proposition**: the higher the need for critical assets in the provision of drinking water services, the higher the probability of observing modes of organisation where decision-rights on these assets are highly centralised.

Methodology

We are testing a proposition derived from the alignment framework, namely that there is a link between the criticality of assets and the degree of decentralisation of decision-rights. We expect to observe modes of organisation where decision-rights are more centralised in the presence of more critical assets. We model this proposition as follows:

$$\mathbf{DECENTRALISATION} = \mathbf{CRITICALITY} * \alpha + \mathbf{X} * \beta + \mathbf{u} \quad (1)$$

where **DECENTRALISATION** denotes the degree of decentralisation of decision-rights in the chosen mode of organisation, i.e. organisational decentralisation, **CRITICALITY** corresponds to proxies for critical assets, **X** is a vector of exogenous control variables and **u** indicates the stochastic error. The choice of the model, an ordered probit regression based on standard maximum likelihood estimations with heteroscedasticity-robust standard errors, is very straightforward and does not, to our knowledge, involve any trade-off with other models.

Ordered probit regressions are used in the case of the dependent variable being qualitative and graduated. This fits our dependent variable, organisational decentralisation. It is a qualitative variable which can be hierarchically ordered according to whether the decision-rights in the chosen mode of organisation are not at all, less or more split across the public authority and a private operator.

We apply this test to the French drinking water sector and use data from the French Agency for Biodiversity (*AFB*, formerly *ONEMA*)⁵. This database is the only one that offers refined information on investments and the state of the distribution network which we can use to define proxy-variables for the notion of criticality. We use data for 2009 which is the most complete data, covering 80% of the population served and hence, according to the *AFB*, providing the best representation of the French water sector.

Before we come to the empirical analysis, we will construct our **DECENTRALISATION** and **CRITICALITY** variables and present the control variables used in the regression.

Construction of the Decentralisation variable

In France, the provision of water services falls under the responsibility of the local public authorities. They can choose to organise these services on their own (direct public management) or with the participation of a private firm. The private operator's involvement can be relatively low (service contracts, management contracts type 1 and type 2), intermediate (lease contracts) or very high (concession contracts)⁶. To classify the modes of organisation according to the extent to which decision-rights are decentralised, we follow Boyer et al. (2001, pp. 4 ff.). The authors match the decision-rights on the various domains of action in water services to the entity holding those rights. From the distribution of decision-rights between the public and the private party, we derive a decentralisation score.

⁵ The data is available on <http://www.services.eaufrance.fr/donnees/telechargement> (accessed 26 July 2017).

⁶ The corresponding French terms are “régie”, “régie avec prestation de services”, “gérance” / “régie intéressée”, “affermage” and finally “concession”.

Table 1:

Decentralisation of decision-rights according to the mode of organisation.

Domain of action	Mode of organisation					
	Public management	Service	Management 1	Management 2	Lease	Concession
<i>Finance</i>	publ	publ	publ	publ	publ/priv	publ/priv
<i>Planning / design</i>	publ	publ	publ	publ	publ/priv	priv
<i>Construction</i>	publ	publ	publ	publ	pub	priv
<i>Renovation</i>	publ	publ	publ	publ	pub	priv
<i>Maintenance</i>	publ	publ	publ	publ	priv	priv
<i>Operation</i>	publ	publ/priv	priv	priv	priv	priv
<i>Collecting / billing</i>	publ	publ	priv	priv	priv	priv
TOTAL public	7	6	5	5	2	0
TOTAL publ/priv	0	1	0	0	2	1
TOTAL private	0	0	2	2	3	6
DR decentralisation	None (100% public)	Low (mainly public)	Intermediate (mainly public)	Intermediate (mainly public)	High (public and private)	Low (mainly private)
DR decentralisation score	0	1	2	2	3	1
(DECENTRALISATION)						

As can be seen, the decentralisation score, our **DECENTRALISATION** variable, ranges from 0 to 3. A score of 0 represents the case of full centralisation since all decision-rights are held by one party. This corresponds to direct public management⁷. A score of 3 represents the case of highest decentralisation, meaning that both the public authority and the private operator hold extensive decision-rights, as under a lease contract. Service contracts and concessions both have a decentralisation score of 1 because most of the decision-rights remain with one party. In the case of service contracts, most decision-rights are held by the public party and in the case of concessions by the private party. Both types of management contracts⁸ have an intermediate score of 2. According to the ideas issuing from the alignment framework, we anticipate that increasing asset criticality goes hand in hand with a higher probability for low decentralisation scores (0, i.e. direct public management, or 1, i.e. service

⁷ Note that according to this approach, another mode of organisation, although irrelevant to our study of France, would achieve a score of 0: full privatisation. In that case decision-rights are also in the hand of a single entity, hence representing full centralisation.

⁸ These management contracts only differ by the remuneration and incentive mechanism for the private operator, which is irrelevant for our study.

or concession contracts) and a lower probability for higher decentralisation scores (3, i.e. lease contracts or 2, i.e. management contracts).

Proxies for criticality

In the absence of direct measures of the criticality of assets we have identified two proxies: the ratio of investments to the length of the network and the existence of a renewal programme for the distribution network.

Water infrastructure includes a variety of critical assets. Although the network of pipelines is probably what comes first to mind, other critical assets comprise pumping stations which might be necessary for the catchment of raw water but also to ensure adequate pressure in the transmission and distribution network. Further examples might be a dam with its gates or intake conduits. The costs relating to all these critical assets are generally estimated to represent 80% of the total costs of water services (Noll, 2002, p. 45)⁹. The *AFB* database provides the amount of investments made. This amount also includes investments in less critical assets (e.g. the refurbishment of the buildings of the water utility) but these costs only represent a small part in comparison to the major part of investments. It can therefore be considered that the overall amount of expenses provides a good estimation of investments relating to critical assets. To obtain our **INVESTMENT** variable, we divide the monetary value of the investments by the length of the network. This ratio indicates the investment effort. The higher the investment effort, the higher the criticality of assets because expenses of the same amount will be relatively more critical in a smaller network than in a bigger network. Investment of 150,000 euros will be more critical in a network of 100 km than in a network of 1,000 km length. An investment effort of 1,500 €/km might indicate the replacement of deteriorated pipes or of intake conduits and refurbishment of gates of a water reservoir. An investment of 150 €/km might indicate the repair of leaks and other less critical transactions.

According to the theoretical reasoning that more critical assets require more organisational centralisation in order to economise coordination costs, **INVESTMENT** is expected to be negatively correlated with **DECENTRALISATION**. For higher investment efforts lower decentralisation scores of 0 or 1 should be found.

A second proxy for the criticality of assets is the dummy variable **RENEWPROG**. It takes the value of 1 if the local public authority has implemented a multi-year programme for the renewal of the network and 0 if not. The existence of a renewal programme translates the need to refurbish an ailing network and hence reflects the need for critical assets. Accordingly, a negative correlation is expected with regard to **DECENTRALISATION**. In presence of a

⁹ These numbers find confirmation in a report on the investments spent in a French municipality (Commune de Thonon-les-Bains, 2012, p. 37).

renewal programme of the water network, modes of organisation with low decentralisation (score of 0 or 1) should be observed.

Control variables

Several further variables might impact on the centralisation or decentralisation of decision-rights in the chosen governance structures. **DENSITY** measures the number of subscribers per network kilometre. The higher the value this variable takes, the denser the network, meaning that more subscribers per kilometre of network must receive water services. Ménard (2009, p. 88) noted in that respect that a denser population requires more significant and specific investments in order to provide water in the right amount and of the right quality with an adequate pressure¹⁰. This idea is in line with the explanation of engineers that capacities of water collection, purification, transmission and distribution are a function of the density of the population (Shammas and Wang, 2011, p. 126). **DENSITY** is therefore expected to be negatively correlated with **DECENTRALISATION**, reflecting a mode of organisation allowing for tighter coordination of core transactions.

Additionally, **INTERCOM** is a dummy variable measuring the existence of an intercommunal arrangement for water provision, i.e. the case where two or more public authorities partner up to provide water services jointly. The variable takes the value 1 for joint service provision and 0 if a single municipality organises the water services. The effect of this variable on the decentralisation of decision-rights is *a priori* undetermined. On the one hand, an intercommunal arrangement increases coordination costs because the different municipalities must coordinate their, often heterogeneous, equipment (Cour des Comptes, 2011, p. 21). In such a perspective, the choice of a highly decentralised governance structure, like a lease contract, would worsen already existing coordination problems. The presence of a private operator with whom decision-rights are shared would add further to the number of actors requiring coordination. As a consequence, there should be a negative correlation between **INTERCOM** and **DECENTRALISATION**. Hence, the existence of intercommunal drinking water provision should increase the probability for more centralised modes of organisation. On the other hand, the fact that municipalities associate might provide them with the possibility to overcome certain deficiencies of resources and capacity resulting in a reduction of transaction costs related to coordination. In such a perspective, intercommunal arrangements could more easily manage the relations with a private operator in a mode of organisation with

¹⁰ The correlation between **DENSITY** and the ratio of the population served to the length of the network was so high that either variable could be used. The **DENSITY** variable was directly contained in the *AFB* database and hence chosen.

highly decentralised decision-rights, such as lease contracts. Therefore, it is also possible that a positive relation between the two variables exists.

Furthermore, the knowledge of critical assets might impact on the decision to decentralise decision-rights or not. Such knowledge is essential for efficient investment decisions. The variable **KNOWLEDGE** captures the information about the state of the network on a scale from 0, corresponding to no knowledge, to 100, meaning very good knowledge. The variable is a joint indicator including different aspects like the existence of a map of the network; an annual update of this map; knowledge on the elements constituting the network; the age for each segment; the localisation and description of annex assets (valves, meters...); the localisation of service pipes; the level of information on works on the networks. Based on the fact that the entity which operates the network gains knowledge of it (Martimort and Sand-Zantman, 2006, p. 764), several cases are possible. If the knowledge of the critical assets is poor, knowledge needs to be retrieved to warrant efficient investment. If the chosen governance structure has highly decentralised decision-rights (i.e. the case of lease contracts) the retrieval of such relevant information on critical assets entails the need for coordination between the public and the private party. Yet, this coordination is costly¹¹. Therefore, the local public authority might prefer to centralise decision-rights, thus economising these coordination costs. In that case, the public entity would either choose direct public management or a service / concession contract. All of these centralised modes of organisation should lead to the increase of knowledge on the critical assets. In the case of direct public management or a service contract, the local public authority would operate the network and gain knowledge of it. In the case of a concession contract, the private operator is also incited to gain knowledge of the network in order to provide efficient investments¹².

Also, if the knowledge on the critical assets is good, the decentralisation of decision-rights will imply lower coordination costs. Therefore, a local public authority might choose a governance structure where decision-rights are highly decentralised because the public party is not dependent on the private firm for the retrieval of knowledge on the network. For these reasons, a positive correlation between **KNOWLEDGE** and **DECENTRALISATION** is expected, based on the idea that little knowledge of critical assets should increase the need for a mode of organisation where decision-rights are more centralised.

¹¹ Also, a lease contract in France has a duration of about 10-12 years. The private operator cannot be sure that his contract will be renewed. Therefore, he might be less motivated not only to maintain critical assets but also to transfer information on them to the local public authority. The local public authority might therefore be wary of lease contracts in situations where the knowledge on the state of critical assets is poor.

¹² This incentive, however, decreases as the term of the contract draws nearer (Chong and Huet, 2010).

Furthermore, following Chong and Huet (2010), the regression controls for local factors that might impact on the choice of modes of organisation and hence decentralisation.

After excluding observations where some variables are missing or erroneous, our final sample contains 410 water services, of which about 50% represent a mode of organisation with complete centralisation of decision-rights (score of 0), 5% with low (score of 1), 5% with intermediate (score of 2), and 40% with high decentralisation (score of 3). Table 2 summarises the explanatory variables and provides some descriptive statistics. Correlations between explanatory variables do not show any anomalies that would call for caution with regard to the econometric test.

Table 2: Definitions of explanatory variables and descriptive statistics.

<i>Variable</i>	<i>Definition</i>	<i>N</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
<i>DENSITY</i>	Number of subscribers / length of transmission and distribution network in km	410	29.18	19.97	2.66	106.73
<i>INTERCOM</i>	Takes value 1 if the local authority organises the water services cooperation with other local authorities	410	0.56	0.50	0	1
<i>KNOWLEDGE</i>	Index for the knowledge of the transmission and distribution network	410	47.05	26.82	0	100
<i>INVESTMENT</i>	Ratio of amount of expenses of water service in € to length of transmission and distribution network in km	410	2,813.04	4,754.39	11.46	67,464.88
<i>RENEWPROG</i>	Takes value 1 if a renewal program for the transmission and distribution network exists	410	0.21	0.41	0	1

Results of the econometric test and discussion

The aim of our analysis is to test an idea expressed by the alignment framework, namely that more critical assets require more centralised modes of organisation. The underlying rationale is that whenever decision-rights on critical assets of water services are split between the public authority and a private partner, there is an important need for coordination between the two parties. Such coordination however is difficult and costly. Therefore, the public authority might prefer to choose a mode of organisation where decision-rights are more centralised in order to economise coordination costs.

Table 3 summarises the results from the regression with the maximum likelihood method.

Table 3: Estimation results for equation (1).

	<i>MLM dependent</i>
<i>Specification</i>	<i>variable:</i>
	<i>DECENTRALISATION</i>
<i>DENSITY</i>	0.0127** (0.00563)
<i>INTERCOM</i>	0.602*** (0.198)
<i>KNOWLEDGE</i>	0.0108*** (0.00406)
<i>RENEWPROG</i>	-0.565** (0.239)
<i>INVESTMENT</i>	-6.30e-05** (2.87e-05)
<i>DEPARTMENTAL FIXED EFFECTS</i>	Included
Observations	410
Pseudo R-squared	0.355

Robust standard errors in parentheses: ***

p<0.01, ** p<0.05, * p<0.1

The variable **DENSITY** is significant at the 5% level. The correlation however is not as expected. The sign is positive and, therefore, does not support the idea that a denser network requires more specific investments which, according to the logic of the coherence framework, would raise the criticality of assets and thereby the need for centralised decision-rights. The higher probability for more decentralisation observed here could be explained by the attractiveness of dense networks for private operators who would then try to obtain such lucrative water contracts.

The characteristic that water services are provided through an intercommunal arrangement raises the probability of decentralised decision-rights. The variable **INTERCOM** is significant at the 1% level. This finding is coherent with the idea that municipalities which associate would reinforce their competencies in managing contractual relations with a private firm in the case of decentralised decision-rights on critical assets. Within an association of municipalities, capacities and resources would be concentrated so that it would be easier to coordinate with a private firm. This increase in capacity would then open the door for the choice of more

decentralised modes of organisation, a choice that might not have been possible if the municipality had been on its own.

The **KNOWLEDGE** variable is highly significant and shows the expected positive sign. This confirms the idea that good knowledge on the network decreases the potential for coordination problems. A situation where the public authority has only little knowledge on the network might result in serious coordination issues in a setting where decision-rights are decentralised. The public party would have to retrieve private information on the network from the operator in order to be able to efficiently renew desolate parts. However, the private firm might not be interested in gaining knowledge on the network and/or transferring it to the public partner. It might not have the right incentive for this type of cooperation, for instance because it cannot be sure that the contractual relation will be renewed in the future. In such a context, the public authority might prefer to centralise decision-rights in order to escape these potential problems.

On the other hand, there is the situation where the public party's knowledge on the network is good, e.g. because an effort has been made in the past to keep up to date the maps positioning the pipes and annex infrastructure. Under such conditions, decentralised decision-rights might be less problematic because the public authority does not depend on the private operator for information on the network. Good knowledge on the network would enable the public authority to efficiently approach critical investments. Hence, the need for coordination would be lower and, accordingly, the coordination costs too, thus facilitating the decentralisation of decision-rights.

Both proxies for critical assets are significant with the expected signs. The findings imply that, in the presence of critical assets, more centralised modes of organisation might be chosen. The existence of an investment program for the renewal of the network (variable **RENEWPROG**) is significant at the 5% level. Since the existence of such a program translates a need for critical assets, this corroborates the idea that centralised modes of organisation (with a decentralisation score of 0 or 1) might be chosen to facilitate the coordination of core transactions.

As expected, **INVESTMENT** is negatively correlated to the decentralisation of decision-rights and significant. This further substantiates the idea that the criticality of assets is linked to the choice of the mode of organisation. Higher investments per kilometre correspond to higher asset criticality and increase the probability for a centralised mode of organisation. According to the alignment framework, this might correspond to the desire to escape coordination problems in situations where decision-rights on critical assets and the related core transactions are split between the public and the private party.

Conclusion and possible extensions

This paper has undertaken the first econometric study of the alignment framework as initially developed by Finger et al. (2005). It has been applied to the French drinking water sector. The alignment framework stresses the importance of the coherence between technological characteristics of infrastructures and matching modes of organisation. The findings from the empirical analysis in this paper corroborate a central idea of the alignment framework, namely that more critical assets require more centralised modes of organisation. The centralisation of decision-rights is a possible solution to coordination problems that might occur in decentralised organisational settings, especially when decision-rights concerning the critical assets are split. The econometric test proposed in this paper indicates indeed that, in presence of critical assets, the probability for more centralised modes of organisation increases.

As a policy implication, when faced with the choice of a mode of organisation to provide water services, local authorities should not exclusively think in terms of public vs private provision. Rather, they should pay attention to the distribution of decision-rights within the possible modes of organisation and also to their knowledge of the underground network. When they have little knowledge of the network whilst at the same time facing the need for critical long-term investments in it, they should avoid modes of organisation where decision-rights on these critical assets are highly decentralised, such as in a lease contract. In a lease contract, the private party operates and maintains the network and gains information on it. In this situation, the public authority would be dependent on the private partner for information on the distribution network, a prerequisite for efficient investment. The private contracting partner would need to transmit his knowledge on the state of the network to the public authority. This would involve high coordination costs. By choosing a more centralised mode of organisation, a concession or direct public management, the public authority can economise these coordination costs.

Since this is the first econometric application of the alignment framework, several challenges remain. There might be possible causality issues: is it the need for critical assets that leads to the centralisation of decision-rights? Or is it because decision-rights are centralised that investment effort is higher? From the point of view of the alignment framework the former possibility would be the right interpretation. Interviews or surveys of water service providers having chosen modes of organisation with highly centralised decision-rights (direct public management, service contracts, and concessions) would help to clarify the causality of the two variables.

Once these issues have been addressed, a wide research program could be opened. A next step could be to study the link between criticality and performance. Do infrastructures where the criticality of assets has been taken into account for the choice of mode of organisation

outperform infrastructures where such alignment is missing? This type of analysis could be facilitated in the case of France by the increasing use of performance indicators in the French water sector.

An additional extension would be to depart from the static view we apply here. In this paper, the criticality of assets is identified as an imminent need for investments. It would be interesting to adopt a dynamic view, allowing for a better evaluation of the criticality of investments in time, by using panel data.

Furthermore, the approach towards criticality is still at its inception in this paper. The concept of criticality in the alignment framework is more detailed and complex. It also covers organisational constraints imposed by the technology in particular transactions when these transactions concern specific infrastructure components. Therefore, it would be relevant to collect more detailed data on infrastructure components, e.g. the type of distribution network, i.e. branch versus loop network, in order to deepen the operationalisation of the notion of critical assets and core transactions. This would allow the use of econometrics to study the idea of technological complexity, another factor motivating the centralisation of decision-rights.

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