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# Organizational Choices, Efficiency and Equity in Local Public Services

*The Case of French Water Supply*

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Thèse

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# Foreword

This Ph.D. dissertation, entitled "*Organizational Choices, Efficiency and Equity in Local Public Services: The Case of French Water Supply*", brings together four chapters in the field of organizational economics and strategy. The General Introduction describes the different research questions addressed in these chapters, as well as the links that can be established between them. The Summary of Findings and Contributions summarizes the results and their implications for research and practice. Nevertheless, each chapter can be read separately. This implies the presence of redundant information across chapters, notably concerning the related literature and the industry studied.

# Abstract


**Organizational Choices, Efficiency and Equity in Local Public Services**
***The Case of French Water Supply***

This dissertation investigates empirically the links between organizational choices and performance in the French water public service. First, because organizational choices can impact performance, the dissertation focuses on the reasons for contracting out the provision of public services and on the impact of such a decision on performance. Second, the dissertation studies the overall technical and allocative efficiency of the industry and whether the diversit of organizational forms can explain current inefficiencies. By mixing the literature on the organization of the firm and the literature on regulation, this Ph.D. dissertation seeks to contribute to the debate on public and private sectors' relative performance and to the improvement of public services.

Chapter 1 focuses on the determinants of outsourcing water provision and the impact of organizational choices on performance. Using a large representative dataset of 2,455 municipalities observed for four years, results show that local authorities with complex services and experience in contracting have a

larger probability to outsource the management of their water public service. How then do organizational choices impact performance? Results show that private management is associated with rather small price and quality premia and lower levels of debt. Chapter 2 analyzes the reasons for public authorities to simultaneously use their own resources and import water from other cities. Results show that complexity of production and contracting capabilities have a positive impact while production capabilities have a negative impact on the probability to use simultaneously external and internal procurement. The impact of such an organizational choice on price is small but positive and can be interpreted as an insurance premium paid to ensure service continuity.

Chapter 3 uses a unique dataset of 177 large decision making units to benchmark the performance of the industry. Results show that technical efficiency is high and that laggards are mainly found under private management. Overall, public and private management scores at rather similar levels when complexity is taken into account. Chapter 4 draws on a standard result in utility regulation requiring two-part tariffs with marginal prices set to marginal costs and fixed fees equal to each customers share of fixed costs. Using a mixture of two datasets based on 4,500 representative municipalities in 2008, the study shows that marginal costs are marked-up by 8% on average. Under price elasticity estimates that are consistent with previous results in the literature, efficiency costs represent around 8 million euros of welfare losses for 2008. Even though the impact is fairly small, efficiency gains from reformed tariffs could be used to fund water assistance programs focused on financially stressed households. The chapter finally discusses the reasons for maintaining prices that differ from the theoretical ideal, such as different pricing strategies between public and private management.

**Keywords:** Public Services, Public-private Contracts, Water, Efficiency, Equity, Industrial Organization, Transaction Costs, Capabilities, Resource-Based View, Public Management.

# Résumé

**Choix Organisationnels, Efficience et Equité dans les Services Publics Locaux**

***Le Cas du Service Public de l'Eau en France***

La présente thèse de doctorat est une étude empirique des liens existant entre les choix organisationnels et leur performance relative dans le service public de l'eau en France. En premier lieu, les choix organisationnels ayant une incidence sur la performance, l'objet de ce travail est de comprendre les motivations de la délégation des services publics au secteur privé et d'analyser le lien causal qui existe entre les modes de gestion et la performance. Dans un second temps, la présente thèse étudie l'efficience technique et allocative des services publics de l'eau en France ainsi que le lien éventuel entre les inefficiences constatées et les choix organisationnels réalisés par les municipalités. Fondée sur les théories de l'organisation de la firme et de la régulation des services publics, cette thèse de doctorat contribue au débat sur la performance relative du secteur public et du secteur privé et à l'amélioration des services publics.

Le premier chapitre traite des motifs de délégation du service public à un opérateur privé et du lien causal qui existe entre cette décision et la performance du service. Les résultats de l'étude, qui porte sur 2455 municipalités observées sur quatre années, montrent que les acteurs publics locaux qui ont des services complexes et une expérience contractuelle ont une probabilité plus grande d'avoir recours à la gestion déléguée. Quel est alors l'impact d'un tel choix sur la performance du service ? Les résultats montrent que le choix du secteur privé entraîne généralement un prix et une qualité de l'eau un peu plus élevés et des niveaux de dette du service d'eau plus faibles. Le chapitre 2 analyse les raisons pour lesquelles de nombreuses municipalités utilisent pour la provision du service public de l'eau à la fois leurs propres ressources en eau et des ressources importées d'autres municipalités. Les résultats montrent que la complexité de la production et l'expérience contractuelle ont un impact positif sur la probabilité qu'une municipalité utilise à la fois l'approvisionnement interne et externe, ce qui n'est pas le cas des capacités de production qui ont un impact négatif. L'impact d'un tel choix organisationnel sur le prix est positif, ce qui peut s'expliquer en partie comme une prime d'assurance afin d'assurer la continuité du service.

Le troisième chapitre réalise, à partir d'une base de données unique, une comparaison de la performance relative de 177 gros services d'eau représentatifs de l'industrie. Les résultats montrent que l'efficience productive de l'industrie est globalement élevée et que les services les moins performants sont généralement en gestion déléguée. Globalement, la performance relative des secteurs public et privé est relativement similaire lorsque l'on prend en compte la complexité des services. Le dernier chapitre s'inspire d'un résultat bien connu de la régulation des services publics selon lequel la recherche de l'efficience allocative impose la mise en place de tarifs en deux parties, une partie fixe et une partie variable. Le prix marginal doit alors être égal au coût marginal et la partie fixe doit être égale au coût fixe moyen par abonné. L'étude, qui s'appuie sur deux bases de données et sur 4500 villes représentatives pour l'année 2008, montre que les prix marginaux sont supérieurs de 8% en moyenne aux coûts marginaux. En prenant en compte des élasticités-prix de la demande qui sont conformes à celles trouvées dans des précédentes recherches, les coûts d'efficience représentent 8 million d'euros pour l'année 2008. Bien que l'impact soit globalement limité, une réforme tarifaire permettrait des gains d'efficience qui pourraient être utilisés pour financer des fonds d'aide à l'accès à l'eau pour les ménages les plus démunis. Le chapitre discute *in fine* les raisons qui pourraient expliquer les différences constatées entre la tarification actuelle et celle théoriquement idéale, à l'instar des stratégies de tarification différentes entre secteurs public et privé.

**Mots-clés:** Services Publics, Partenariat Public-Privé, Eau, Efficience, Equité, Organisation Industrielle, Coûts de transaction, Capacités, Théorie de la Ressource, Management Public.

# Contents

# General Introduction

## Organizational Choices and Performance

The field of strategic management describes why firms differ in their organizational choices and subsequent performance. Organizational choices implies governance forms which are based on hierarchy, i.e. the authority relation between the principal and the agent, or the market, based on price mechanism, to reach individual and collective goals. Performance of organizational choices can be approximated by outcomes such as access, consumer satisfaction, quality, quantity or value for money, i.e. the marginal or average cost of production. Two other concepts are nonetheless important but often unconsidered when assessing performance: technical efficiency defined as the ratio of outputs to inputs; allocative efficiency for which there is no available alternative that is universally preferred[1]; and equity defined as the fairness of distribution of ser-

[1] The term allocative efficiency refers to the situation where no reallocation can make one person better off without making another worse off, i.e. a Pareto-optimal situation. This situation is often simply called "economic efficiency". Allocative efficiency should not be mixed-up with "allocated gains", i.e. the welfare gains associated to the allocation of a good to the buyers who value it the most. When there are no shortages, allocative inefficiency result from deviations from the minimum cost input ratios. Technical efficiency refers to the best combination of inputs to produce a given level of outputs but is not necessarily allocated efficiently. Technical inefficiency is simply related to deviations, based on inefficient management, from the production frontier.

vice costs and benefits between different groups.

Over the last forty years, the standard framework developed for analyzing the choice of organizational governance has been transaction cost theory (Williamson [1975] based on landmark article by Coase [1937]). This theory puts forth the notion that efficient organization necessitates matching transactions which require higher levels of coordination with organizational forms providing the necessary levels of coordination in a cost effective manner. The two primary conceptual insights provided by transaction cost theory are that the governance of exchange agreements between economic actors is costly and that governance forms vary in their ability to facilitate exchange depending on the attributes in the transactional environment. The choice of organizational governance form is seen as a central means through which management affects the costs of monitoring and administration or, more specifically, the costs of negotiating and writing contracts and monitoring and enforcing contractual performance (Williamson [1975]). Although transaction costs economics advocates selecting a governance form that minimizes the sum of total production and transaction costs, its application has emphasized the importance of the costs associated with governing and monitoring transactions. Due to the economies of scale and specialization available in the marketplace, as well as the administrative and incentive limits associated with managing economic transactions within a firm, i.e.hierarchical governance based on authority, the theory generally assumes that simple market contracts provide a more efficient, or lower cost, mechanism based on prices for managing economic exchanges.

This conclusion meets somehow the standard neoclassical framework in which markets generate important efficiency benefits for an economy, even though the literature on organizational choices suggests that markets are only one of the governance modes that can be selected to organize production.

Nevertheless, as opposed to the neoclassical economic conception of the firm as a production function that relates a firm's level of capital and labor to its productive output, transaction costs economics describes the firm as an efficiency-inducing instrument that facilitates exchange between economic actors. Given that most complex contracts are incomplete, the theory holds that in some situations the costs of market exchange may increase substantially and surpass the technical efficiencies provided by the market. Hierarchy is however better fitted to transactions with a high likelihood of ex post bargaining situations resulting in potential opportunistic behavior. This situation is most likely to occur in economic exchanges that involve specific investments[2], i.e. co-specialized assets that are customized for a particular use or purpose. "Misalignment" between transaction characteristics and organizational form is the source of underperformance.

However, transaction costs economics do not take into account the fact that organizations develop certain capabilities or know-how that is embodied by managers, employees or organizational routines (Penrose [1959] and Wernerfelt [1984]). The resource-based view theory provides two primary conceptual insights that answer to the the first premise. First, it recognizes that factor markets exist wherein firms may develop or acquire the resources necessary for product market competition. Second, the resource-based view points out that the resources which lead to persistent performance are much broader in nature and more difficult to accumulate than the tangible assets and factors of production typically emphasized in neoclassical economic theories. For instance, the resource-based view literature draws upon discussion of the administrative and entrepreneurial skills of top management team (Penrose [1959]). Early contributions by Wernerfelt [1984] and Barney [1986] emphasized the ability of firms to create and sustain competitive advantage by acquiring and defend-

[2] Asset specificity is the main motivation for the make-or-buy decision in transaction costs economics but uncertainty and frequency are two important factors that raise the potential for opportunistic behavior.

ing advantageous resources positions. The resource-based view suggests that the ability to leverage valuable, firm-specific resources may lead to a marginally higher likelihood that firm-hierarchy will be optimally chosen to manage economic exchange. As a result, a firm with unique capabilities will internalize activities which are complementary to its unique features and for which they have relevant competencies and expertise.

A limitation to both transaction costs economics and the resource-based view of the firm is that they typically treat the sourcing decision as a binary choice, to make or to buy.[3] Researchers in economics and strategy steeped in the resource-based and transaction costs tradition have adopted this dichotomy. In practice, however, firms can and do both make and buy the same goods. Furthermore, they may use sourcing methods that, while ostensibly fitting into one of the two dichotomous categories of market or hierarchy, actually combine both. The "make-and-buy" phenomenon is underlined in Adelman [1949] who argues that firms concurrently source, i.e. mix internal and external procurement for the exactly same good, in times of demand uncertainty, pushing the fluctuations in volume onto suppliers in order to ensure full internal capacity and stable production. Porter [1980] adds to this view that firms will also concurrently source to gain an increased understanding of the production process and thus better monitor suppliers. A large literature on concurrent sourcing has emerged in the recent years and usually combine transaction costs economics with the resource-based view of the firm (Gulati and Puranam [2006] and Krzeminska et al. [2012]). The impact of concurrent sourcing on performance is ambiguous and is actually, to the best of our knowledge, neither studied empirically nor theorized.

[3] Even hybrids in Williamson's theory are a single procurement mode that is mixing hierarchy and market but does not imply that a part of the production is organized through hierarchy and another one through the market at the same time.

For the transaction cost theory and the resource-based view of the firm, aligning governance modes to the characteristics of respectively the transaction and the firm is the only reason for differences in outcomes between organizational choices. As Masten [2002] underlines, an organizational form that is superior will always result in large efficiency gains compared to how the same unit would have performed under the other alternative. This statement is however limited. Williamson [1963] analyzes the "expense preference behavior of managers", the expansion of inputs and outputs beyond profit maximizing levels, and views firm as maximizing utility through the pursuit of non-profit-maximizing policies. In this view, organizational choices may not reflect the same goals. In this literature, managers are supposed to follow not only profit maximization or firm expansion but to maximize their preferences. Such a framework, that draws on Barnard [1938] and Simon [1951], is useful to compare management practice in different organizational forms.

If we can expect two concurrent organizational forms to have rather different impact and different routines in producing a similar good or service, the question becomes also the one of the impact of organizational choices on the industry's efficiency. The outcomes of organizational choices raise not only the question of performance at the organization level but also the question of global value creation at the industry level. As we have noted above, efficiency can be measured as the ratio of outputs to financial inputs, i.e. technical efficiency, or as the economic efficiency gains that can occur when marginal price is set equal to marginal cost, i.e. allocative efficiency. In principle, increased efficiency leads to economic gains overall but can alter the fairness of the distribution of costs and benefits between groups, i.e. it can be costly from the equity point of view. It is possible to measure the relative technical efficiency of various organizational forms using benchmarking methods (Farrell [1957]). These benchmarking methods compare the inputs used to obtain a certain level of outputs in a given industry. It is useful to relate the distribution of an organizational form to the overall technical efficiency of the industry or to make simple means comparison between two organizational forms.

As a measure of performance, equity and fairness considerations have been largely let aside in the organization and governance literature. Based on standard welfare economics, a large part of the regulatory literature studies the design of tariffs to promote allocative efficiency and equity in use. Raising awareness of potential changes in pricing that would occur if regulation required prices to be aligned with costs conditioning on observed outsourcing choices and consumption patterns is an issue we examine in the following thesis. Such equity considerations are now more and more taken into account by management scholars who do not measure welfare but underline the need for global value creation (see recent papers by Klein et al. [2010] and Kivleniece and Quelin [2012]).

## Public Service Improvement

Governments all around the world search to improve the provision of public services. A public service is a service which is provided by government to people living within its jurisdiction, either directly or through a contract with a public or a private organization.[4] The last thirty years have witnessed a change in the division of responsibility between the state and the private sector for the delivery of public services. As evidence of weaknesses of in-house government provision has accumulated, there has been a global trend toward greater involvement of the private sector. Apart from privatization of formerly nationalized firms, this has often involved contracting out public services to both nonprofit organizations and for-profit firms, while maintaining public owner-

[4] A public good is a good that is both non-excludable and non-rivalrous, i.e. individuals cannot be excluded from use and its use does not reduce availability for others. Public services include the provision of public goods but a part of public goods are available at no-cost.

ship and responsibility in providing goods and services. Depending on history of private sector participation, the laws and the industry, more or less complex forms of arrangements have been encouraged to externalize supply of public services. Economists, such as Shleifer [1998] have questioned whether there is at all a case for public ownership, even if social goals are taken into account, when the opportunities for government contracting are exploited.[5]

A large part of the theoretical literature is usually based on fundamental arguments of welfare economics: a competitive equilibrium is pareto-optimal. In this sense, government intervention is required in the case of natural monopolies, externalities, public goods and to a certain extent, for distributional concerns. In regulated industries with natural monopolies, the argument for a competitive equilibrium is weaker but still holds for several reasons. Government's goals can be inconsistent with efficiency (see the public choice literature, e.g. Niskanen [1975]), be malevolent (see Spiller [2008] on public actors' opportunism) or fund inefficient firms (the soft budget constraints as noticed by Kornai [1986]). A major theme in the literature is that public ownership is inherently less efficient than private ownership (Alchian and Demsetz [1972]) since ownership is diffused among all members of society, and no member has the right to sell its share. Given those aspects of public ownership, there is little economic incentive for any owner to monitor the behavior of the firm's management and a narrow-range of monitoring devices under public management. Overall, the critique is not only on the allocation of decision rights but also on public managers themselves.

In reality, the frontier between privateness and publicness is not always easy to determine. Both organizations can be for-profit. Both organization

[5] "When the opportunities for government contracting are exploited, the benefits of outright state ownership become elusive, even when social goals are taken into account." (Shleifer [1998])

can be partly privately or publicly-owned. Both organizations can receive subsidies funded by national or local taxes. Some public agencies can even be managed by personnel that are governed by private-law contracts. For the sake of this thesis, we will define private management as the supply of a service or a product by a firm that is fully owned by private investors and thus responds only to economic controls such as profit maximization. Public management designs a form of management that is affected in some of its behavior and processes by the political authority, which is potentially conflicting with the profit maximization principle (Bozeman and Bretschneider [1994]).[6] In each public service, private and public organizations often co-exist and compete, so we assume that each organization goal is to maximize its efficiency. Even if this definition is clearly limited, it underlines why the performance of publicly managed organizations is supposedly lower than privately managed organizations: frequent changes in policy can create instability while satisfying different constituencies complicate decision-making and the absence of competitive pressures decreases allocative efficiency. As a result, thoughts on how to improve public services has been divided in two streams.

The first stream is based on the new public management (Hood [1991], Osborne and Gaebler [1992]) which supports that public organizations should import managerial processes and behavior from the private sector. The main argument of the new public management is that public managers have less incentives to be efficient and have to respond to different political authorities. New public management particularly emphasizes that public and private service providers competing for resources and markets is a way to get things done better. Increasing private sector participation is still at the top of the political agenda[7] and as a consequence the public-private management debate contin-

[6]Firms can of course spend in corporate political activism and thus be influenced in turn by political control but their lobbying expenses follow the profit maximization ideal.

[7]See for example the Lisbon Agenda in Europe (2000) or the Commission Attali in France (2007).

ues to rage, often on regulatory issues, especially in public service provision in times of tight budget constraints. As a result, a subsequent professional literature (European Commission [2003], PriceWaterhouseCoopers [2005], McKinsey [2009] for example) describes the "dos and donts" in which private sector participation can be optimal to provide public services.

The second literature stream proposes that there is little point in seeking to draw lessons from new public management as public and private organizations fundamentally differ in their goals. A vast literature in public management and organization theory tries to measure how public and private organizations differ one from another (Boyne [2002], Perry and Rainey [1988] for example). Porter [1990] notices for example that "company goals are strongly determined by ownership structure, the motivation of owners and holders of debt." Public and private management may want to use pricing strategy to indulge their consumption preferences. For example, public managers may want to decrease prices for consumers and fund a part of its investments using taxation for bureaucratic reasons. Private managers may seek to maximize their profits to satisfy stockholders. Studies made by researchers in public management do not use the same methodology but find a similar results: public managers have a stronger desire to serve the public interest (Rawls et al. [1975]). Private operators and public actors use different criteria to judge the standard of public services and may apply different weights to the same criterion. Nevertheless, public service improvement is likely to be valued by all constituencies, even if the valuation differs between groups and over time.

At its core, the decision to use external or internal procurement for public service provision in the water sector is no different from choosing whether to contract for the use of an asset or not; such problem which has been widely studied in the use of inputs in various industries (Monteverde and Teece [1982], Masten [1984]), markets for coal (Joskow [1985] and Joskow [1987]), not to mention trucking (Nickerson and Silverman [2003]) for example. Public service improvement can be linked to higher private sector participation or competition between operators but also to regulatory issues, such as promoting overall efficiency or equity in use. It is moreover useful to identify public and private managers' preference to have a better understanding of the impact of organizational choices on performance.

Finally, in regulated industries such as public service provision, there is a debate on the relative importance of regulation and organizational form to improve efficiency. To some extent, regulation may be more important that organizational choices to explain efficiency. This is the base of two theoretical streams. The first one gives an important role to information. Agency models analyzed in Laffont and Tirole [1993] suggest deviations from cost-minimization by effort-averse managers, especially when managers lack high-powered incentives or proper monitoring. Designing incentives is the way to improve performance. A complementary literature is based on yardstick competition (Shleifer [1985]). Yardstick competition is a regulatory tool under which a private operator's financial outcome depends on its relative performance *vis-à-vis* that of its reference group. This regulatory tool, based on artificial competition, is for instance used in the British water industry, in the Norwegian bus industry and in the Japanese passenger railway.

The second part of the literature is based on standard welfare economics and studies the design of tariffs to promote efficiency and equity in use. This historical debate has given way to a rich theoretical literature examining utility pricing in relation to the public interest. Hotelling [1938] first argues that all prices in an economy should be set equal to marginal cost, with fixed costs paid for with government subsidies from income, inheritance and land taxes. Coase

[1946] considers that efficient pricing in regulated markets implies two-part tariffs. Further theoretical developments usually have considered a Ramsey-Boiteux pricing to derive how prices should be marked up above marginal cost (Baumol and Bradford [1970]) in order to meet the social revenue requirement. Creating shared value is an outcome that one should consider when studying public service improvement (Porter and Kramer [2011]).

## Research Gaps and Problem Definition

While industrial economists and strategic management researchers have, over the years, mostly viewed each other with suspicion, this dissertation matches the two different backgrounds to explain managers' strategies, their efficiency impact and how regulation can improve efficiency.

The typical strategy in the empirical literature has been to relate the make-or-buy decision - to measures of contractual frictions, such as asset specificity or transaction complexity. Those theories mainly focus on decisions at the boundary of the firm and often on cases where firms integrate to internalize the transfer of some tangible good or service (see Bresnahan and Levin [2012] for a recent literature review). In contrast, a broad literature insists on the fact that firms may seek to expand or acquire other firms in order to leverage their internal capabilities or exploit superior management capabilities (Wernerfelt [1984]). The unit of analysis is not the transaction but the firm. As a matter of fact, firms highly differ in their contracting and production capabilities for example. A large literature matching transaction costs analysis with the resource-based view of the firm has emerged in the late nineties (Poppo and Zenger [1998]) and it is now common to match both theories to analyze organizational forms (see Argyres [1996], Silverman [1999], Leiblein and Miller [2003] and Mayer and Salomon [2006] for example). Using a mixture of both theories enables to inch closer to understanding why managers select an organizational form.

Recently, several papers matched both theories to understand why firms both make *and* buy the same good using a mixture of transaction costs and the resource-based view of the firm. This growing debate on concurrent sourcing has been empirically studied in Veugelers and Cassiman [1999] and more recently in He and Nickerson [2006], Parmigiani [2007] and Parmigiani and Mitchell [2009]. Particularly, Parmigiani [2007] defends the idea that concurrent sourcing is an organizational form per se, different from market and hierarchy. In this view, theorized by Krzeminska et al. [2012], concurrent sourcing fosters a better understanding of hybrids, i.e. governance mode mixing the market and the hierarchy at the same time. A contingent view is that concurrent sourcing refers to the splitting up of the total volume being procured across multiple modes. In this view, managers concurrently source for various reasons but they can always decide to produce or to buy a marginal part of their volumes for strategic reasons. Understanding non-corner solutions for organizational forms and why managers choose different modes of procurement is an old question that requires new research.

While the determinants of the organization of the firm have been largely studied, rarely an attempt has been made to link the integration decision to economic outcomes such as cost-efficiency, prices or public service quality (see the literature review by Shelanski and Klein [1995] and Bresnahan and Levin [2012]). Quantifying the effects of organizational structure poses some challenges. The first challenge is the econometric problem of selection. It is difficult to observe counterfactuals for alternative organizational forms for example. As a result, cross-sectional differences as much as time-varying differences are often difficult to study carefully. A second difficulty with measuring the effects of a governance choice is that cases - and data - do not always provide an overall view. Organizational choices can have large complementarities (Milgrom and Roberts [1990], Holmstrom and Milgrom [1994]). Complementarities refer to a situation in which the performance consequences of a choice depend on other choices. For example, private sector participation in providing public services can increase prices and quality at the same time while decreasing public account debt. In this thesis, we aim at properly assessing the impact of organizational choices on performance, using complementary indicators of performance (see the recent articles by Hortacsu and Syverson [2007] and Atalay et al. [2012] which use complementary indicators of firm performance before and after integration to measure the impact of vertical integration on performance).

By using complementary indicators of performance, our assessment of various organizational choices leads to a better understanding of managers' preferences. While public choice clearly points the lack of efficiency and accountability of public managers in spending, the expense preference theory developed by Williamson [1963] insists on managerial discretion in daily business behavior, which can lead in differentiated goals and outcomes. Even if the original framework of Williamson is designed in order to give a theoretical explanation to the use of discretionary resources by managers, it has a clear echo in the public management literature. To the extent that the managers' objectives are also discretionary, private managers will advantage quality and impermeability of accounts rather than affordability, while public managers - perhaps because they are influenced by the political authority and can use taxes to fund public services- tend to advantage affordability rather than quality and non-permeability of accounts. Even if the dissertation does not examine differences in internal administrative practice between public and private organizations, it looks at significant differences in performance patterns between public and private organizations. In public management, it is sometimes called the “essential differences” between public interest values and private sector’s motivations (Bozeman and Loveless [1987]).[8] Despite vast evidence, the approach to characterize public and private management style has often been ill-equipped to respond to exceptions, to classify organizations and to provide statistically robust results (Boyne [2002]). The dissertation uses empirical analyses to get a better understanding of organizations’ outcomes.

Organizational choices impact performance at the transaction- or firm-level but they have also an impact on the market structure. Improving overall efficiency can be achieved by increased competition, strong incentives and tariff regulation for example. Little is known about the impact of competition on organizational changes and how these changes can impact performance. In the organizational literature, organizational changes are the outcomes of misalignment between organizational choices and transaction- or firm-level characteristics (Nickerson and Silverman [2003]). Additional evidence is needed on the reasons for and the impact of changes on performance. Incentives to increase performance include benchmarking methods that link operational revenues to the satisfaction of certain indicators, usually cost-efficiency. The use of benchmarking methods provides a better understanding of the reasons for differentiated performance between organizational choices and production units. Giving more importance to the results of such study can be a way to foster technical efficiency at the industry-level.

Finally, tariff regulation is an important means to promote efficiency and equity in use. Because of the lack of available data, few papers (Davis and Muehlegger [2010], Borenstein and Davis [2011]) properly assess the efficiency costs of misfit tariffs. Such an evaluation demands a considerable amount of

[8]Probably the best advance comes from Bozeman and Bretschneider [1994] who suggest a dimensional model of publicness that gives particular attention to organizational resource processes and activities such as goal setting, structuring and design, and organizational maintenance.

information on consumer behavior. Data on production units' revenues and consumer behavior are helpful to run tariffs reforms promoting efficiency and equity. Overall efficiency and equity are too often let aside of the literature on public management (Boyne [2003]). Looking whether they are complementary indicators of the performance of organizational choices (does private management have a negative impact on access to public services?) and at their potential impact on related markets (should we use taxation or price mechanism to fund public services?) are still open questions. The dissertation bridges several organizational theories together with the managers' behavior and regulation theories. It does so by evaluating different but connected challenges in four essays in an overarching framework.

## Objective, Research Questions and Scope

The aim of this dissertation is to explore and enlarge the understanding of organizational choices and how these choices affect performance from the different actors' perspectives. The research objectives of this thesis consist of theoretical, empirical and managerial ones. The dissertation consists of two parts. In the first part, organizational choices are endogenous. Hence we are interested in the reasons why parties select an organizational choice and how it can impact performance. The second part takes organizational form as exogenous and assess the industry's overall technical and allocative efficiency. We also build several policy reforms that can promote efficiency and equity in use. A more detailed subset of questions can be identified with respect to this relatively broad research agenda. First, what are the reasons for and the impact of organizational choices and organizational changes on performance? Second, why do local authorities concurrently source the same good and what is the impact of these trades on performance? Third, what is the efficiency gap between organizational forms and how can we explain it? Fourth, can we promote efficiency and equity in use in residential water use in France? The dissertation is organized in the format of four related chapters, each devoted to a specific set of questions raised above. This implies the presence of redundant information across chapters. Research approach, methodology and contributions of the essays are quickly described in Tables 1 and 2.

This dissertation focuses on the organization, the efficiency and the equity of water public services in France. France has long been a pioneer in private sector participation for the provision of public services. In times in which public actors did not have the financial power to build roads, bridges or water networks, the private sector was solicited through concession contracts. Historically, private sector participation in public services has been recognized as necessary to support access and service continuity. From the 1980s on, increasing tight budget constraints on the local public authorities and supposedly higher efficiency gains that could be expected from private firms provision probably drove the trend towards outsourcing such services to the private sector. As a matter of fact, in France, most of the water and sanitation public services but also school canteens for example are currently provided by private firms. Contracting out for public services is an arduous task. Public and private managers must find the right arrangement, negotiate the contractual format, manage hazards that can occur during the partnerships, prevent distortions that can occur in the markets, promote access and service continuity. In public utilities, private sector participation and the monopolistic nature of public services raise several questions such as organizational performance and how different organizational forms can promote efficiency and equity in use.[9]

The water public service in France is a good candidate for an empirical study of the impact of private participation for several reasons. First, water is

[9] For example, a large reform of water tariffs is presently discussed by the French government. Recently, several major cities, including Paris, decided to revert back to direct public management and decreased prices.

a quasi-homogeneous good with very little differences in quality. Second, the market for water distribution is large, covering the whole French population. Third, private sector participation has been growing since the 1980s. As private firms now provide for more than 60% of the French municipalities, the impact of private participation is thus large. Fourth, there are no secondary markets that can mitigate the impact of the private sector participation or transfer it to other markets, as such was the case in telecommunications or wireless internet access. An interesting characteristic of private firms operating in the water market is that the main operators have a long experience in providing water. They are actually long-time regionally located firms that built the first networks. Fifth, this market is suitable for an empirical analysis given the availability of a comprehensive and representative municipal-level dataset including thousands of municipalities for 1998, 2001, 2004 and 2008. Finally, perhaps the most salient motivation for investigating this industry is that the make-or-buy decision has been the focus of substantial policy and media attention in the recent years with major cities like Paris reverting back to direct public management.

The main conventional wisdoms on public versus private management do not apply to this sector. The main capital assets, the pipes providing water and connecting people, are publicly owned. Only the public service can be privately managed. As an industrial public service, in cities with more than 3,000 inhabitants, revenues and costs from water provision are reported in a separated account of the municipality. According to the principle "water pays water", revenues can only be derived from users and should cover costs. As the water public service has its own account, it can fund a part of the (public) investments using debt. Contrary to standard monopolies, directly managed water utilities are not in principles funded by taxation. It does not mean however that their primary goals are not linked to political aims. What is interesting in this sector is that ownership is public and taxation in principle cannot fund production. Only decision-making is different, one is delegated to a private manager, while the other is directly undertaken by the public manager.

Even if the institutional backgrounds and the inherent research questions are closely linked to water provision in France, the results and the main findings of the thesis can be extended to a whole brand of (regulated) industries and even to the organization of the firm. The “make or buy” and the integration decision have for example been studied in a long sequence of empirical studies dating back at least to Monteverde and Teece [1982] and Joskow [1985], and covering all sectors from cement (Hortacsu and Syverson [2007]) to the film industry (Gil [2007]) among others (see Shelanski and Klein [1995], Richman and Macher [2008] and Bresnahan and Levin [2012] for extensive literature reviews). The efficiency and equity of implemented rates are also a widely studied subject in the literature, ranging from regulated industries (Ito [2010] for example) to taxation (Saez [2004]) and consumer behavior (Lambrecht et al. [2007]). We discuss in detail the implications, contributions and possible extensions in the general conclusion of the dissertation.

The dissertation is based on a mixed-method research approach that combines quantitative data from multiple primary and secondary sources, representing various time periods between 1998 and 2009, and reflects multiple levels of analyses (city and industry levels), that allow for triangulation on the predictive validity of the proposed frameworks. The research design across chapters is partially based on devising creative ways to tackle measurement challenges that emerged along the way. Combining data from multiple sources, from different time-periods and at different levels of analysis is not without its challenges, and the particular challenges, trade-offs, and solutions, are discussed precisely in each chapter. The dissertation is based on empirical tests of the performance of different organizational forms at the micro and the industry levels.

Each chapter of the dissertation draws on two different datasets. For the specific need of each study, those datasets were combined with others. The first dataset is the IFEN-SOeS dataset, collected by the French Environment Institute and the Environment Ministry, which is a nationally-representative municipal survey of the public service of water. This sample is representative of the total French population and the local public authorities where they are living: all sizes of local authorities are proportionally represented and municipalities with more than 5,000 inhabitants are all included. There has been four data collection in the last ten years. The data collection proceeds as follows. Municipalities fill the database, then data is checked by the Environment Ministry. The IFEN-SOeS is the only national representative dataset on public water services in France. The database includes information at the municipal level about water consumption by domestic customers and municipalities characteristics that can influence water consumption. An important feature of the IFEN-SOeS dataset is that, in addition to characteristics about the contract such as ownership structure, it provides high-quality information about water bill structure. We matched the IFEN-SOeS dateset with data from the French National Institute for Economics and Statistics (INSEE in French) on households' incomes.

The second dataset was built specifically for the dissertation. It is based on the collection of an unique extra dataset of 177 large water utilities for 2009. The data was collected with the help of Lyonnaise des Eaux. The data collection has proceeded as follows. We launched a data collection on the top 720 cities in France, representing 320 water utilities. Data was obtained for 297 public services and, because of missing data, obtained a complete sample of 177 water utilities. As these water utilities all include at least one city with 15,000 inhabitants, they usually share their network with small cities around. This unique and fine-grained original dataset, called OSEA, coveris revenues and information on numerous variables for roughly 1,000 cities of the IFEN-SOeS dataset.

## Design and Main Findings of the Four Chapters

### Part I: Organizational Choices and Performance

The first part of the dissertation is based on building block models linking transactional frictions and differences in the capabilities of firms offering explanations for when and why organizational choices might lead to differentiated performance outcomes. The typical strategy in the literature has been to relate observed organizational choices to measures of contractual frictions and in few cases to link organizational forms and performance, before and after the "integration" decision. Organizational choices are different depending on the unit of analysis that we consider. At the city-level, managers can choose to lease or to manage the water public service. At the service-level, managers can choose to produce or to buy water from another municipality. Such a distinction is somewhat similar to vertical and horizontal integration. It raises several questions such as whether theories based on transactions and capabilities can explain these organizational choices and whether these variables impact performance *in fine*. This first part is divided in two chapters that will be briefly presented.

What are the reasons for and what is the impact on performance of leasing the public services to a private operator? This is the research question to which we try to answer in the first chapter entitled *Do Markets Reduce*

*Prices?*, we draw on the literature on organizational performance based on landmark articles by Coase [1937] and Williamson [1975]. For these authors, the governance structure of a transaction is a function of the relative costs of transacting in markets and organizing procurement within the firm. Misalignment between governance structure and transaction characteristics potentially has large impacts on efficiency: an organizational form that is superior will always result in large efficiency gains compare with how the same unit would have performed under the other alternative. We first analyze average differences in retail prices between public and private provision using different regressors controlling for heterogeneity between observations and organizational outcomes. As the choice of a managerial form is never randomized, we need to find an alternative methodology which mimics a natural experiment. We adopt a quasi-experimental differences-in-differences methodology. We then study price evolution for utilities switching from private to public management and from public to private management. Even if a shift may not be randomly carried out, municipalities switching from an organizational form to the other offer a privileged laboratory to assess public versus private performance. We then discuss potential endogeneity problems by connecting the decision of the municipality to outsource the public water service with its contractual capabilities.

We find two key results. First, private provision of water is more expensive than public provision, even controlling for the characteristics of privately provided water. However, the price premium is lower than simple means comparison would suggest. Second, focusing on switchers reveals expected yet small differences in retail prices for consumers. Municipalities switching from public to private management are characterized by increasing prices, while municipalities switching from private to public management experience price decrease. However, these price changes are not always significant. This means that public (private) provision is not directly associated with lower (higher) prices.

Why, then, are prices higher under private management? Difference in accounting rules for example can lead to cross-subsidies between different municipal budgets under private management. Here, we particularly document some important questions such as municipal debt and water quality. We find that private management is associated with lower municipal debt as compared to public management. This can explain why the gap between public and private management reduces through the time interval, as debt refund increases under public management. Water quality is also significantly improved under private management but the difference remains low. This is consistent with the fact that public and private management do not share the same goals.

The present study has several policy and methodological implications. First, municipalities that face make-or-buy decisions must be aware that price differences are largely driven by the structural characteristics of the network. In comparable cities, the price premium from private participation is low. Second, municipalities must take into account that lower prices under public management can be linked to higher future debt refunds. Overall, our results show that organizational choices have rather similar patterns in terms of performance. Third, our analysis underscores the difficulty of determining in advance how provision types impact performance. Fourth, this chapter highlights differences in results coming from several methodologies. It provides a clear structure for researchers focusing on the impact of a strategy or a choice in governance. It is in line with Angrist and Pischke [2010] who suggested that industrial organization would benefit from a more intense focus on "natural experiments", Hamilton and Nickerson [2003] who declared that research in management needed more robust results to draw conclusions about the veracity of theory and Masten [2002] who called for more robust results of the performance of organizational forms.

In the second chapter entitled *Make or Buy in Water Markets* we focus on the reasons why water public services both make and buy water, a pattern that is called concurrent sourcing (Parmigiani [2007]). Existing theory typically treats the sourcing decision as a dichotomous choice, to make or to buy (Williamson [1975]). Scores of theoretical and empirical studies in the transaction costs economics tradition buttress the distinction between those two sourcing modes. Strategy theorists immersed in the resource-based view theory also adopt this dichotomy, arguing that production units will make goods for which they have relevant competencies and expertise and buy goods when they lack such skills. Yet, in practice, firms' sourcing decisions are more complex. Often, their sourcing choices, apparently fitting into one of the two binary categories of market or hierarchy, actually combine aspects of both. This is the case in the French water public service where utilities import more than 10% of their resources. This concurrent sourcing mode, also known as partial or tapered integration and plural sourcing is the focus of this chapter. Prior research suggests that concurrent sourcing is quite prevalent. For example, in the classic make-or-buy work by Monteverde and Teece [1982], they define as "make" any component for which the firm produces 80% or more of its requirements.

This study is linked to a rich emerging literature. Parmigiani [2007] finds that concurrent sourcing makes up a governance choice itself rather than an organizational form between market and hierarchy. Parmigiani and Mitchell [2009] find that concurrent sourcing is chosen when firms have sufficient expertise while they rather make in order to know. Theoretical perspectives are described in Puranam et al. [2012] and Krzeminska et al. [2012]. Puranam et al. [2012] put forward complementarity and constraints to explain the degree of make-and-buy. Their analysis suggests that constraints - such as limits to scale and barriers to exit - push firms away from corner solutions while incentive and knowledge complementaries pull towards equal usage of the two procurement modes. Krzeminska et al. [2012] insist on transaction costs economics and capabilities as the main theories to explain concurrent sourcing.

Traditional logic suggests two primary reasons why firms would use partial integration. The make-and-buy phenomenon is first underlined in Adelman [1949] who argues that firms concurrently source in times of demand uncertainty, pushing the fluctuations in volume onto suppliers in order to ensure full internal capacity and stable production. Porter [1980] adds to this view that firms will also concurrently source to gain an increased understanding of the production process and thus better monitor suppliers. Recent papers focus on firms that make and buy exactly the same input. While the knowledge argument is difficult to test in the case of water which is a standardized good with an usually non-observable production process (water flows through the pipes from a city to another) the uncertainty and production capabilities argument remains valuable for the study of water trades between cities. Yet, it does not mean that knowledge is absent from our research: we argue that contracting capabilities resulting in know-how in managing contracts can have robust impacts on the decision to concurrently source and on overall performance.

The local trades in the water industry are interesting to study for several reasons. Firstly, internal production provides a significant portion of the cities' requirements and a robust - but based on location - spot market exists. This raises a puzzle: if the utility is producing a significant quantity of its requirements, it suggests that it can do so due to scale or scope economies, resource abundance, specific investments, or combinations of these. Therefore, we expect the sourcing production unit to have lower per unit production costs than outside suppliers. However, the actual prices charged to the sourcing firm may be even higher, due to the risk borne by having transaction costs in implementing contracts and unused capacity (Carlton [1979]). Secondly, the nature of the volume uncertainty explains why cities contract between one and another to trade water. If volumes are fluctuating, but predictable which is the case in the water sector, then outside suppliers can fill their capacity with other utilities during the slower times and perhaps not charge a premium to the sourcing firm. In this sense, concurrent sourcing may be a stable sourcing strategy. Contracting is also feasible if the sourcing firm simply wants insurance against volume uncertainty due to seasonal consumption, shortages, or strikes. Nevertheless, securing supply flows in and of itself is not a sufficient reason to source both internally and externally. In water markets, as in many commercial transactions, supply markets are relatively thin due to some specific investment or capabilities required to manage contracts and thus sourcing firms have few potential external suppliers. This raise a trade-off between specific investments required for concurrently source a good and capabilities to negotiate with limited suppliers.

The contributions of this chapter are twofold. First, it applies the nascent "make and buy" framework to a regulated industry. Second, despite a growing literature on concurrent sourcing, it is to the best of our knowledge the first chapter to empirically asses the performance of concurrent sourcing.

In Part I, we focus on the decision to outsource the public service and on its outcomes. This organizational decision is at the firm boundary, such as whether a firm should make or buy a particular input. The second part of the dissertation moves from this level of analysis to explain how the overall efficiency of the entire industry and how it is linked to the overall organizational choices made in the industry.

## Part II: Promoting Efficiency and Equity in Public Services

Part II focuses on efficiency measured as technical efficiency and allocative efficiency. Organizational choices are taken as granted. We first aim to assess the overall technical efficiency of a representative set of utilities of the industry. We then compare the relative efficiency of organizational forms. The question of technical efficiency raises the one of allocative efficiency. If there are production units that are not technically efficient, it means that it is possible to produce the same quantity of goods at a lower cost and then to increase one consumer's welfare without making another worse off. In chapter 4, we assess the overall performance of the industry in terms of allocative efficiency and access to the market for the poor. This part is based on policy reforms and regulatory issues to improve public services. Part II is divided in two chapters that are now quickly presented.

In the third chapter, entitled *Efficiency in the Public and Private French Water Utilities: Prospects for Benchmarking*, we address the relative technical efficiency of 177 public and private water suppliers in France by computing the best practice frontier of our sample. To identify managerial efficiencies, we evaluate the ability of water services to minimize their revenues in the provision of a set of outputs, relative to the performance of other producers in our comparison set. We consider that efficient water services operate with low revenues, thus covering their costs but reducing their margins in order to limit distortions. However, efficiency also depends on the characteristics of the environment in which provision is carried out. Moreover, hazards such as individual "luck" or "misfortune" measured as statistical noise must be unbundled from managerial efficiencies. We take these effects into account by considering a set of environmental variables that can impact technical efficiencies. Our empirical approach is different from previous studies on French data. To control for hazards and structural differences, we mix a non-parametric approach (Data Envelopment Analysis, DEA) with a stochastic model (Stochastic Frontier Analysis, SFA) in a three-stage approach introduced by Fried et al. [2002]. The three-stage model is the following. In the first-stage, a conventional input-oriented DEA using only inputs and outputs is applied to obtain initial measures of services' performance. In the second stage, we regress the slacks of the first-stage against the environmental variables and an error term using a Stochastic Frontier Analysis (SFA). This method allows us to purge the managerial inefficiencies from the possible environmental effects and statistical noise. Finally, the third-stage re-evaluates producer performance and provides improved measures of managerial efficiency, since the data have been purged of both environmental effects and statistical noise. We then rank decision making units (DMU) according to their efficiency scores that range between 0 and 1.

Chapter 3 contributes to the previous literature in two different ways. Firstly, in addition to traditional measures of technical efficiency, we consider some measure of quality and environmental variables to assess the performance of DMUs. Network performance is fundamental because it usually warrants civil society, especially as water is being considered a scarce resource. Secondly, by mixing different benchmarking models, our results contribute to the literature on public-private management comparison. Our results show that utilities under private management are on average more complex to manage. Accounting for environmental variables increase efficiency by 0.1 under private management while it only lifts up efficiency by 0.059 for public management. However, even after having taken environment variables and statistical noise into account, private management remains on average less efficient than public management. Directly managed services have an efficiency score of 0.883 against 0.823 for private management. As a summary, even if the technical efficiency gap is narrowing after correcting for structural differences, it remains significantly positive. This gap partly results from a widespread technical efficiency of DMUs under private management.

One question that arises is whether inefficiencies negatively impact equity. In the fourth and final chapter, *Efficiency and Equity in Two-Part Tariffs: The Case of Residential Water Rates*, we study efficiency not from the technical point of view but from the allocative point of view. We explore the vital role of tariffs and regulation to promote efficiency and equity in use. In France, as in many regulated industries, in the simplest case, water tariffs are divided in two parts: a fixed fee, no matter the level of consumption, and a volumetric charge depending on water consumption. A standard result first developed by Coase [1946] is that setting marginal prices to marginal costs would eliminate the deadweight loss associated with monopolies. The local monopoly then recoups its fixed costs through fixed fees equal to each customers share of fixed costs. Although it is compulsory to use two-part tariffs in the French water sector, operators tend to charge fixed fees and volumetric charge that differ from the theoretical ideal.

This chapter applies the standard monopoly framework to answer the following questions: (1) How do marginal prices differ from marginal costs? (2) What are the distributional impacts of a switch from current tariffs to Coasian tariffs? (3) Do the reformed tariffs fit better the equity considerations? (4) What are the efficiency costs from the observed deviations from marginal cost pricing? The chapter examines a nationally representative dataset of 4,500 French municipalities for 2008. The dataset contains demographic and economic information about households at the municipal level, but also a large set of information on water demand and supply, such as consumption, spendings, rates and some water utilities characteristics.

We find that marginal prices differ from marginal costs. Even if the range of the deviation is limited - a 8% deviation is observed for the volumetric charge - these markups impose a deadweight loss by leading customers to consume too little water and to support fees that do not represent capital costs. Rebalancing rates to match the Coasian tariffs imply large increase in welfare for consumers, especially those living in cities with lower incomes. This is due to the fact that the correlation between water consumption and income is significantly positive but weak. Consequently, reformed price tariffs benefit more to large consumers more than poor households. As a matter of fact, after the transition to Coasian tariffs, cities in the first fourth quintiles regarding the per-unit income would experience decreases in their average bills that are almost similar, between 21.45 and 20.07 euros per year. We thus consider alternative water assistance programs focusing directly on cities with lower per-unit incomes. We then compare the costs of these assistance policies to the current efficiency costs. Under conservative levels of price elasticities, a transition to marginal cost pricing implies efficiency gains of 8 million in 2008, a level that is low compared to the global profits of water industries in France. However, these efficiency gains suffice to fund assistance programs such as decreased fixed fees for poor households. The chapter highlights several explanations for the current price distortion, such as firms profit maximization (small versus large consumers?), resource scarcity (markup versus Pigouvian taxes?) and management structure (public versus private?). We finally discuss the validity of the results, precisely regarding consumers responses to marginal prices and the link with related markets, such as sanitation.

## Outline of the Dissertation

Following this general introductory chapter, we proceed to elaborate on each study conducted as part of the dissertation research. Each chapter represents an essay with its own core set of assertions and recommendations and should be viewed as an autonomous study with linkages to the broader conceptual framework and central research question. Though there are several recurring themes, which we elaborate upon in the conclusion, each chapter is self-contained with its own specific research questions, theoretical review and development, its own data used and method of analysis adopted, and ends with its own conclusions and recommendations.

Table 1: Summary of Part I: Research Questions, Methodology and Main Results

| Research Questions | Methods and Data | Main Results |
|---|---|---|
| • **Chapter 1**: Do Markets Reduce Prices?<br>• **Research Questions**: What are the reasons for and the impact of organizational choices on performance? Why do organizational forms lead to different outcomes? | • Econometrics: OLS, Within-FE and AR(1)-FE.<br>• Matching Methods and Differences-in-differences for robustness checks.<br>• IFEN-SOeS dataset on 2,455 cities observed for four years (1998-2001-2004-2008).<br>• Additional subsample extracted from OSEA. | • Complexity and contracting capabilities are inputs for organizational choices.<br>• Using complementary indicators of performance show rather small but significant differences in performance.<br>• Switching from public to private management increases prices after several years, not in the short-run; switching from private to public management decreases prices in the first years, not in the long-run.<br>• Public and private managers have differentiated preferences in their privileged outcomes. |
| • **Chapter 2**: Make or Buy in Water Markets<br>• **Research Questions**: What are the reasons for and the impact of concurrent sourcing? | • Econometrics: OLS, Probit, Heckman Selection Model.<br>• IFEN-SOeS dataset on more than 12,000 observations for four years (1998-2001-2004-2008).<br>• Additional subsample extracted from OSEA. | • Transaction costs and capabilities are inputs for the decision to both make and buy the same good.<br>• Asset specificity mitigates the impact of contracting capabilities on concurrent sourcing.<br>• Concurrent sourcing occurs when volume uncertainty is predictable to ensure service continuity.<br>• Concurrent sourcing leads to a price premium that is comparable to an insurance premium, and to transaction costs. |

Table 2: Summary of Part II: Research Questions, Methodology and Main Results

| Research Questions | Methods and Data | Main Results |
|---|---|---|
| • **Chapter 3**: Efficiency in the Public and Private Water Utilities: Prospects for Benchmarking<br>• **Research Questions**: Is there an efficiency gap between public and private management when we control for structural differences? Is the technical efficiency related with the size of the utilities? | • A three-stage method mixing DEA (in the first and third stage) and SFA (in the second stage).<br>• Robustness check using econometrics (OLS).<br>• OSEA dataset of 177 decision making units for 2009. | • The technical efficiency gap between public and private management is low, around 6%.<br>• Structural differences explain half of the gap found in the first stage.<br>• Technical efficiency does not appear to be linked to the size of the decision making units. |
| • **Chapter 4**: Efficiency and Equity in Two-Part Tariffs: the Case of Residential Water Rates<br>• **Research Questions**: How do marginal prices differ from marginal costs? What are the distributional impacts of a switch from current tariffs to Coasian tariffs? Do the reformed tariffs fit better the equity considerations? What are the efficiency costs from the observed deviations from marginal cost pricing? | • Econometrics: Heckman selection model and standard OLS.<br>• Simple computations using bootstrapping methods.<br>• IFEN-SOeS on 4,500 cities for 2008, INSEE and OSEA on 137 utilities representing 650 cities for 2009. | • There is a 8% deviation from marginal cost pricing.<br>• Rebalancing prices to match the Coasian tariffs imply a large increased welfare, between 21.45 and 20.07 euros depending on the income quintile.<br>• The distributional impact of the Coasian tariffs is however low, compared to well-designed water assistance programs.<br>• The overall deadweight loss for the national industry in 2008 is rather low, around 8 millions euros, but sufficient to fund (a part of) assistance programs. |

# Part I

# Organizational Choices and Performance in Local Public Services

CHAPTER 1

# Do Markets Reduce Prices?*

## 1.1 INTRODUCTION

For the last forty years, the role of the public sector in providing basic services such as electricity, gas, water or telephone with a natural monopoly component was hardly questioned. All over the world thousands of regulated monopolies have been opened to competition for service provision with different options to organize the supply of goods. A large part of the theoretical literature on the subject, based on organizational performance, heavily draws on landmark works by Coase [1937] and Williamson [1975]. For these authors[10], the governance structure of a transaction is a function of the relative costs of transacting in markets and organizing procurement within the firm.

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[10]See Williamson [1985] for the theoretical background and Bresnahan and Levin [2012] for a recent literature review on the state of the art.

“Misalignment” between governance structure and transaction characteristics potentially has large efficiency effects: an organizational form that is superior will always result in large efficiency gains compare with how the same unit would have performed under other alternatives.

This paper studies the impact of private management on retail price in residential water industries in France. As an empirical laboratory, we use a representative dataset of 2,455 French cities observed four years: 1998, 2001, 2004 and 2008. A first look at simple patterns in the data is instructive. A first glance at Table (1.1) shows how the prices are related to the organizational form. The price premium is almost 30 euros on average for a standard bill. Other studies on the subject show that private management is often associated with higher prices, even if the price premium lowers when one takes into account panel data and sufficient controls for heterogeneity between utilities (see for example Chong et al. [2006] for a cross-sectional study of 5,000 French water utilities in 2001 and Chong et al. [2012] for a panel study of 3,700 water utilities between 1998 and 2008).

We first analyze average differences in retail prices between public and private provision using different regressors controlling for heterogeneity between observations and organizational outcomes. As the choice of a managerial form is never randomized, we need to find out an alternative methodology which at best mimics a natural experiment. We adopt a quasi-experimental differences-in-differences methodology. We then study price evolution for utilities switching from private to public management and from public to private management. Even if switchers may not be random, municipalities switching from an organizational form to the other offer a privileged laboratory to assess public versus private performance. We then discuss potential endogeneity problems by connecting the decision of the municipality to outsource the pub-

Table 1.1: Descriptive Statistics

| | Definition | Whole Sample | Private Management | Public Management |
|---|---|---|---|---|
| **Panel A: Price Equation, city-level data** | | | | |
| Price | Standard Price for 120 cubic meters (deflated in 1998 price) | 144.605<br>(43.980) | 153.902<br>(45.341) | 124.018<br>(32.410) |
| Consumption Density | Ratio of billed units in thousands on network length in kilometers | 17.188<br>(16.980) | 17.742<br>(17.900) | 15.960<br>(14.667) |
| Independence | Ratio of water production on production plus imports | 0.911<br>(0.196) | 0.899<br>(0.212) | 0.938<br>(0.149) |
| Network Performance | Ratio of billed water on billed water plus leaks | 0.753<br>(0.120) | 0.758<br>(0.115) | 0.742<br>(0.131) |
| Ln(pop) | City population logged | 7.793<br>(1.617) | 7.886<br>(1.596) | 7.589<br>(1.645) |
| Touristic Area(=1) | City is touristic | 0.131<br>(0.323) | 0.124<br>(0.330) | 0.106<br>(0.308) |
| Limitation (=1) | Water consumption can be limited | 0.061<br>(0.238) | 0.061<br>(0.239) | 0.059<br>(0.235) |
| Investment Program (=1) | Investment program on the water networks | 0.674<br>(0.469) | 0.675<br>(0.468) | 0.669<br>(0.471) |
| Pool of Cities (=1) | Cities are grouped to provide public services | 0.726<br>(0.446) | 0.751<br>(0.433) | 0.671<br>(0.470) |
| Touristic Area (=1) | City is touristic | 0.119<br>(0.323) | 0.125<br>(0.331) | 0.135<br>(0.342) |
| Treatment 2 (=1) | Simple disinfection of water | 0.551<br>(0.497) | 0.506<br>(0.500) | 0.654<br>(0.476) |
| Treatment 3 (=1) | Heavy disinfection of water | 0.155<br>(0.362) | 0.167<br>(0.373) | 0.127<br>(0.476) |
| Treatment 4 (=1) | Treatment 3 plus extra-controls | 0.179<br>(0.382) | 0.213<br>(0.409) | 0.102<br>(0.334) |
| Treatment 5 (=1) | Mixed treatment including treatment 4 | 0.054<br>(0.226) | 0.059<br>(0.236) | 0.043<br>(0.203) |
| Treatment 6 (=1) | Mixed treatments including treatment 2 or 3 | 0.054<br>(0.227) | 0.053<br>(0.223) | 0.058<br>(0.234) |
| Ground Water (=1) | Water comes from a ground source | 0.128<br>(0.335) | 0.142<br>(0.349) | 0.098<br>(0.297) |
| Mixed Water (=1) | Water comes from ground and underground sources | 0.186<br>(0.389) | 0.209<br>(0.407) | 0.136<br>(0.343) |

Note: Panel (A) describes data concerning the estimation of prices. The panel includes 6,765 observations for private management and 3,055 observations for public management.

Table 1.2: Descriptive Statistics (continued)

| | **Definition** | **Whole Sample** | **Private Management** | **Public Management** |
|---|---|---|---|---|
| **Panel B: Other Controls, city-level data** | | | | |
| Urban (=1) | Area considered as urban | 0.159<br>(0.366) | 0.165<br>(0.372) | 0.145<br>(0.352) |
| PPP Sanitation (=1) | City has contracted out the sanitation service | 0.567<br>(0.496) | 0.704<br>(0.456) | 0.261<br>(0.439) |
| Water quality | Compliance ratio of microbiological quality tests | 0.958<br>(0.157) | 0.967<br>(0.131) | 0.933<br>(0.202) |
| Number of Tests | Number of tests to measure water quality compliance | 103.841<br>(285.200) | 120.93<br>(331.670) | 65.942<br>(125.282) |
| Failed Tests | Number of tests that not meet the level of compliance | 0.647<br>(1.565) | 0.618<br>(1.434) | 0.713<br>(1.821) |
| Subcontracting Capabilities | Ratio of water imports and exports on total billed water | 0.192<br>(0.309) | 0.212<br>(0.329) | 0.148<br>(0.256) |
| **Panel C: Contractual Renewal and Switches, annual data** | | | | |
| Contract Renewal (=1) | Incumbent is renewed at the end of the contract | 280.750<br>(186.026) | - | - |
| Switch to Public Management (=1) | City in private management remunicipalizes the water service | 71.333<br>(54.827) | -<br>- | -<br>- |
| Switch to Private Management (=1) | City under public management goes in private management | 53.333<br>(34.025) | -<br>- | -<br>- |
| Switch from a Firm to another (=1) | City under private management changes the delegatee | 61.000<br>(58.693) | - | - |

Note: Panel (B) presents data used for other regressions. Panel (C) gives descriptive statistics about contracts' renewals and switches. All observations are represented for the four years. The panel includes 6,765 observations for private management and 3,055 observations for public management.

lic water service with its contractual capabilities.

We find two key results. First, private provision of water is more expensive than public provision, even controlling for the characteristics of privately provided water. However, the price premium is lower than simple means comparison would suggest. Second, focusing on switchers reveals expected yet small differences in retail prices for consumers. Municipalities switching from public to private management are characterized by increasing prices, while municipalities switching from private to public management experience price decrease. However, these price changes are not always significant. This means that public (private) provision is not directly associated with lower (higher) prices.

Why, then, are prices higher under private management? We argue in section 1.5 that differences in price between public and private management can be rooted in several explanations. Difference in accounting rules for example can lead to cross-subsidies between different municipal budgets under private management. Here, we particularly document some important questions such as municipal debt and water quality. We find that private management is associated with lower municipal debt as compared to public management. This can explain why the gap between public and private management reduces through the time interval, as debt refund increases under public management. Water quality is also significantly improved under private management but the difference remains low. This is consistent with the fact that public and private management do not share the same goals.

The present study has several policy and methodological implications. First, municipalities that face make-or-buy decisions must be aware that price differences are largely driven by structural characteristics of the network. In comparable cities, the price premium from private participation is low. Second, municipalities must take into account that lower prices under public management can be linked to higher future debt refunds. Third, our analysis underscores the difficulty of determining in advance how provision type impacts prices. Fourth, this paper highlights differences in results coming from several methodologies. It provides a clear structure for researchers focusing on the impact of a strategy or a choice in governance. It is in line with Angrist and Pischke [2010] who suggested that industrial organization would benefit from a more intense focus on "natural experiments", Hamilton and Nickerson [2003] who declared that research in management needed more robust results to draw conclusions about the veracity of theory and Masten [2002] who called for more robust results of the performance of organizational forms.

The water public service in France is a good candidate for an empirical study of the impact of private participation for several reasons. First, water is a quasi-homogeneous good with very little differences in quality[11]. Second, the market for water distribution is large, covering the whole French population. Third, private sector participation has been growing since the 1980s. As private firms now serve more than 60% of the French municipalities, the impact of private participation can thus be large. Fourth, there are no secondary markets that can mitigate the impact of the private sector participation or transfer it to other markets, as such was the case in telecommunications or wireless internet access. Fifth, this market is suitable for an empirical analysis given the availability of a comprehensive and representative municipal-level dataset built by the French Statistical Office and including thousands of municipalities for 1998, 2001, 2004 and 2008. Finally, perhaps the most salient motivation for investigating this industry is that the public-private controversy has been the focus of substantial policy and media attention to explain price-differences

[11] Water quality in France has long been guaranteed and is drinkable across the whole French territory, even in overseas territories.

between procurement modes.

The paper is linked to a long-established research theme in economics, management science and organization theory that studies the link between ownership and performance. Economists have been keen on analyzing the public vs. private ownership debate in public utilities (see Villalonga [2000] for a theoretical and empirical literature review[12]) but also in the competitive market (see Davies [1971],Caves and Christensen [1980] and Vining and Boardman [1992] for early empirical studies on the subject). A substantial body of empirical evidence documents the superior efficiency of private firms relative to comparable public firms and the improvement of efficiency after privatization (see La Porta and López-de Silanes [1999] and Chong and López-de Silanes [2004] for comprehensive studies and Megginson and Netter [2001] for a large literature review). Empirical comparisons of private and public ownership in developing countries have been widely studied in the managerial literature (see Ghorpade [1973] for an early paper on India and Peng et al. [2004] for a comprehensive study of ownership and performance in China) and shed light on public versus private strategies. Firms' strategies are also analyzed in Schargrodsky [2003] who compares public and private firms in the US newspapers industry and finds that private ownership lowers selling price.

[12]Theoretical backgrounds are usually based on fundamental arguments of welfare economics: a competitive equilibrium is pareto-optimal. In this sense, government intervention is required in the case of natural monopolies, externalities, public goods and to a certain extent, for distributional concerns. In regulated industries with natural monopolies, the argument for a competitive equilibrium is weaker but still holds for several reasons. Government's goals can be inconsistent with efficiency (see the public choice literature, e.g. Niskanen [1975]), be malevolent (see Spiller [2008] on public actors' opportunism) or fund inefficient firms (the soft budget constraints as noticed by Kornai [1986]). A major theme in the literature is that public ownership is inherently less efficient than private ownership (Alchian and Demsetz [1972]) since ownership is diffused among all members of society, and no member has the right to sell their share. Given these aspects of public ownership, there is little economic incentive for any owner to monitor the behavior of the firm's management. Ownership may not be as important as regulation itself. Agency models suggest deviations from cost-minimization by effort-averse managers, especially when managers lack high-powered incentives or proper monitoring (see Laffont and Tirole [1993] for the theoretical analysis of agency-models). Overall, we would expect markets to better allocate resources and reduce prices.

This results from different managers' strategies and tastes, such as the quality vs. diffusion trade-off, something that is observed in the public management literature (see Boyne [2002] for a review). Organization theorists such as Perry and Rainey [1988] and Klein et al. [2010] proposed an agenda on more research on the effectiveness and efficiency of alternative governance mechanisms than the market.

The paper is organized as follows. Section 1.2 presents water provision regulation and section 1.3 presents briefly the dataset. Section 2.4 describes the empirical strategy and discusses results of the impact of private participation on prices. Section 1.5 discusses the results regarding their methodological implications. A brief conclusion follows.

## 1.2 Water Market Regulation

### The Provision of Water in France

In France, as in most European countries, municipalities must provide local public services that have public good characteristics. Municipalities monitor prices, control entry and exit of firms into the market, organize competition and ensure uninterrupted service. Water provision refers to the production and the distribution of water and sewage implies wastewater collection and treatment. Water provision and sewage are two distinct public services and can be managed by two different operators. We focus in this paper on water provision. If the responsibility for public services' provision is public however, its management can be either public or private. Although some municipalities manage production through direct public management and undertake all operations and investments needed for the provision of the service, the dominating organizational form is private management. Under private management, the main contractual form is delegated management.

An official report by Dexia, a French financial intermediary, states that 63% of French medium-sized cities contract out the services of drinking water treatment and distribution and 58% also contract out their sewerage services. It is however difficult to have an accurate estimation of how many municipalities and communities have contracted out both services with the same operator. According to the Cour des Comptes [2011], the highest financial court in France, 71% of the population is covered by a private operator for water provision and 56% for water sewage. In this case a private operator, independent of the local government, is hired to manage the service and operate facilities through one of the four different private-public arrangements. The most common is the *lease* contract in which the operator manages the service, invest in the network and gets a financial compensation through consumer receipts. Under a *concession contract*, the external operators also undertakes construction risk, as it must finance a large part of investments over the duration of the contract. These contractual agreements differ from the previous ones in that operators share risk in exchange for greater decision rights and claims on revenues. Other contracts can be chosen by the local authority such as the *gerance* in which it pays an external operator a fixed fee, or an *intermediary management contract*, i.e. a gerance contract but with a small part of the operator's revenues depending on its performance. Such contracts provide few incentives to reduce costs and transfer no risks and decision rights to a private operator. Although there is a large range of contracts, the participation of the private sector is characterized by a concentration on three major companies. These companies share more than 90% of the private market with their subsidies and other private companies operate mainly in small cities.

Contrary to other industrialized countries, there is no price-cap or rate-of-return regulation for water utilities in France as there is no national regulator. Such regulation has been replaced by a contract in the case of a private operator, or a decision of the municipality board in the case of public operation. In the case of delegated management, rules have been defined to ensure that standards are respected during the operation to limit the opportunistic behavior of operators and preserve competition between firms. First, since the "Sapin Law" (1993) a national legislative framework governs the form of the private sector participation and the conduct of the bidding process. The institutional framework to select the private partner is the following. If the public authority chooses a lease or a concession contract, it selects its partners in two steps. First, the public authority launches a classical invitation to tender which is open to all interested private water companies. Second, there is a negotiation phase between the public authority and potential entrants that it shortlisted. At the end of the negotiation, the public authority chooses its final partner for the duration of the contract. The selection of the private company follows the *intuitu personae* principle according to which the municipality or the community sets a list of criteria to select the firm that is considered as the best partner[13].

Second, a strong regulation on contract duration and delegatee's obligations has been implemented in 1995 with the "Barnier Law". As a matter of fact, water quality in France has increased and is now relevant for more than 99% of the tests and a lot of investments have been made to prevent leaks. However, because regulation is made through contracts between the two parties, depending on the respective power of negotiators and with some contracts signed a century ago, there are doubts about the possibility of the parties to regularly adapt the tariffs to the needs of the utilities.

[13]However, the number of bidders remains low, around 1.9 for each bidding process (Guérin-Schneider and Lorrain [2003]).

Furthermore, rules have been defined to ensure that standards are respected during the operation to limit the potential opportunistic behavior of operators. These rules support water quality, duration of contracts and information about management and provision quality. In the case of water quality, a precise definition of more than 60 verifiable quality parameters has been set by the 1992 Water Act to ensure that water services, would they be private or public, respect quality standards. Consequently, water quality is respected and is rarely below a 95% score of conformity to the standards of the microbiological analysis. Moreover, limits on duration have been implemented and management and provision information is now required to be publicly reported. To ensure competition among operators, the “Barnier Law”(1995) clearly limit the duration of contracts and includes an automatic renegotiation of the contract every five years. To reduce information asymmetries, the executive power passed a decree in 2007 that forces municipalities and communities to provide 14 performance indicators in the mayor's *Annual Report on Prices and Service Quality* (RPQS in French). These performance indicators and other data about water and sewerage services have been collected from 2009 on by the *French National Observatory of Water and Aquatic Environments* (ONEMA in French) to provide users and citizens with information about their water services.

### Price Settings

In the case of delegated management, public authorities face the classic regulatory problem: they find themselves in an information asymmetry position and have few tools to carry out their essential tasks. However, rules have been implemented to limit opportunistic behavior by private operators. For example, in renegotiating prices, operators are constrained by the fact that in administrative contracts, all renegotiations that significantly change the value (by more than 5% of the value of the initial contract) of the contract trigger a new selection process of the private operator. Even if this power is rarely used, it provides a credible threat to local authorities in order to prevent opportunistic behavior from an operator.

As we have seen above, price setting is different whether the local community has chosen to delegate the service to a private firm or not. Under direct public management, the municipality council designs rates in order to generate revenues that allow the utility to cover its costs. French legislation requires the water utility budget to be balanced following the so-called "revenue-recovery principle". Prices are thus set to cover operating and capital costs[14]. Administrative account rules are devised so that municipalities hold two separate accounts for the water utility budget. The first account is an operating budget and the second is an investment budget. Net revenues from the operating budget are automatically transferred to the investment budget in order to limit operating costs. This is usually the case if the municipality undertakes a multi-year investment program. While the "revenue-recovery principle" usually implies a zero-margin cost structure, margins are however possible but the way they are used is highly controlled by administrative rules.

Under private management, the rate structure is determined by projecting financial accounts provided by the operator over the duration of the contract. The contract includes periodic revisions of water rates using a price index adjusting formula. The relationship between the local municipality and the firm is formalized by means of a contract that specifies a price structure, a formula of price revision and negotiated clauses allowing for exceptional condi-

[14]There is little historical evidence of the application of this principle. However as large cities' accounts are now published every year, there is strong evidence of the application of this principle in recent years. The highest financial court in France, the Cour des Comptes [2011], has notified several municipalities that their rates were too high, therefore using municipal budgets to fund non-water spendings, or too low, i.e. subsidized by another municipal budget. However these notifications are rare.

tions. Since the bargaining power is often considered to be favorable to firms, the price structure is likely to reflect a monopolistic behavior rather than social welfare maximization.

In the water sector, empirical results on the impact of a governance form on prices are not clear. Chong et al. [2006] use a 5,000 French municipalities' database for 2001 and find *ceteris paribus* an 11-euro premium of private management relative to the direct public management on baseline bills of 120 cubic meter consumption. This result is confirmed by Carpentier et al. [2006] using treatment effects. They however conclude that private management copy with harder operating environments. Both papers conclude that local governments are keener to outsource the organization of water public services if they are more technically difficult to provide. The price premium of private management is found also in other countries (see Hall and Lobina [2005] for case studies on the UK and all over the world and García-Valiñas et al. [2012] for a literature review on France, Germany and Spain). Such a body of evidence is nevertheless contrary to the common intuition that private participation lowers prices.

## 1.3 Data

### Descriptive Explanations for Outsourcing

The unique dataset we use in this study merges three datasets: the French Environment Institute (IFEN-SOeS), the French Health Ministry (DGS) and the French National Institute for Economics and Statistics (INSEE). The unit of observation is a municipality per year. We observe a set of 2,455 cities in France over four years: 1998, 2001, 2004 and 2008. These cities are taken from a representative set of municipalities. The final dataset is made of 9,820 observations over the four years. Mean covariates and standard deviation are presented in Tables (1.1) and (1.2) for the whole sample and separately by management type. We also built an extra subsample to test the impact of public debt on the marginal price of water that is presented in subsection 1.5.

The IFEN-SOeS, collected by the French Environment Institute and the Environment Ministry, is a nationally-representative municipal survey of the public service of water. This sample is representative of the total French population and the local public authorities where they are living: all sizes of local authorities are proportionally represented and municipalities with more than 5,000 inhabitants are all represented. The IFEN-SOeS database provides detailed information about water public services and municipalities' characteristics. There were four data collection in the last ten years. The data collection proceeds as follows. Municipalities fill in the database, then the data is checked by the Environment Ministry. The IFEN-SOeS is the only representative national dataset on water public services available.

The database includes a lot of information about water supply at the municipal level - e.g. billed water in thousands, water sources, treatments and municipalities' characteristics that can influence water consumption. It includes also some data coming from the census made by the INSEE. We know for example whether the city is located in a touristic area. The latest variables are important controls when one tries to explain the price of water: on the one hand, touristic areas face larger levels of consumption during some periods of the year and need better performing networks; on the other hand, water consumption is low in some regions such as the south of France. We create dummies to take into account the density of water consumption in the network. We also compute some characteristics of the cities. For example, using regulatory indicators provided by the National Bureau of Water (ONEMA in French), we consider a city to be rural if the ratio of billed water and the length of mains is smaller than 10 cubic meters and to be urban if this ratio is larger than 30 cubic meters. Cities with a ratio between 10 and 30 are considered semi-urban. These dummies provide helpful controls to normalize consumption levels from a municipality to another.

An important feature of the IFEN-SOeS dataset is that, in addition to characteristics about the contract such as ownership structure, it provides high-quality information about water bill structure. The standard consumption is 120 cubic meter a year per household as defined by the National French Statistics Institute. At the baseline consumption level, we know for example the price paid by consumers, the amount of the fixed-part and the share of the variable consumption[15].

The Health Ministry (DGS) dataset finally reveals information about water quality. Local authorities responsible for the quality of water have to systematically fill in a database containing information about the number of quality tests and whether these tests have been rejected or not. This provides helpful control over the quality of water when one is interested in the difference in pricing from one city to another.

Descriptive statistics relative to the price equation are presented in Panel (A) of Table 1.1. The main result from the descriptive statistics can be summarized as follows: municipalities under private management face higher prices but also higher costs. Some variables do not have a clear impact. High con-

[15] An assumption that is related to the computation of the marginal price is that there is no multi-tier rates in water industries for consumption that are close to the baseline level. This assumption holds for French water industries, see Porcher [2012b].

sumption density for example ensures that fixed costs are covered but demands regular interventions on the network to avoid interruptions. Network performance also can be considered as the result of high investments or can only be inherited from the previous operator.

Panel (A) in Table 1.1 illustrates how private management is associated with more difficult services. For example, ground water is usually associated with higher treatment complexity because it is more polluted than underground water. Overall, ground water is associated with higher production costs compared to underground water. Water treatments performed by the operator before the water is distributed are important cost-shifters. Indeed, water treatment does not only approximate the complexity of service provision but also the level of specific investments needed to operate the service. A telltale story is that underground water is generally more stable over time and that has two advantages. First, it reduces uncertainty about the evolution of costs. Second, treatment costs are usually lower when water is pumped from the underground. Under mixed sources of water, costs may be higher than for ground or underground sources as the utility may need a treatment factory for each type of water. Treatments are sixfold and coded between 1 and 6 in the IFEN-SOeS dataset. In the simplest case, there is no treatment. In this case, the *treatment* variable takes value 1. When raw water needs disinfection, *treatment* takes value 2. The value is equal to 3 if raw water needs a heavy disinfection treatment and equals 4 if water needs a heavy disinfection treatment plus extra controls. The variable takes 5 and 6 when mixed treatments are needed, the most difficult treatment being 5. As Table 1.1 shows, private management is associated with higher complexity and less underground water; that can explain differences in costs and thus in prices.

Information for other controls is presented in Panel (B) of Table 1.2.

Controls are mainly about water quality which turns to be higher under private management than under public management. The number of tests that do not meet the compliance level is also on average lower under private management. Panel (C) finally gives information about contract renewals and switches for the whole sample. On average, 280 contracts are renewed every year for our 2,455 cities, which represent 16% of the stock of contracts in our dataset. Moreover, we observe switches from public to private management and vice versa. There are on average every year in the dataset 71 switches from private to public management and 53 switches from public to private management. Obviously, there are rather low organizational changes in our dataset because of the length of the contracts is on average 20 years in the dataset and 12 years for contracts signed after 1995. There are two reasons for these low rates of organizational change: on the one hand, the longer are the contracts, the higher are adjustment costs to switch from an organizational form to another; on the other hand, inertia can be the outcome of such embedded relationships. These contractual characteristics are useful to test the validity of the argument according to which private participation is associated with higher prices.

Descriptive statistics give some patterns of municipalities and utilities that are directly managed or outsourced. It is clear that private management occurs in municipalities with difficult context, such as limitation of water consumption, complex treatments, low raw water quality and touristic area for example. We also observe that private management is more frequent in cities with contracting capabilities, for example cities that contracted out the sanitation public service. Moreover, large cities are more keen on contracting out their local public services, probably because they have more resources to monitor contracts. Another argument, following Joskow [1987], is that large (or urban) municipalities have relatively easy access to multiple water suppliers, while small (or rural) municipalities have fewer options to outsource their water public service. Contrary to Monteverde and Teece [1982] for example, we do not observe a positive relationship between complexity or specificity and in-house production. We will use in the further more detailed econometric analysis above a model that consider complexity as impacting price but not selecting private management. We discuss more deeply the hypothesis of endogeneity in section 1.5.

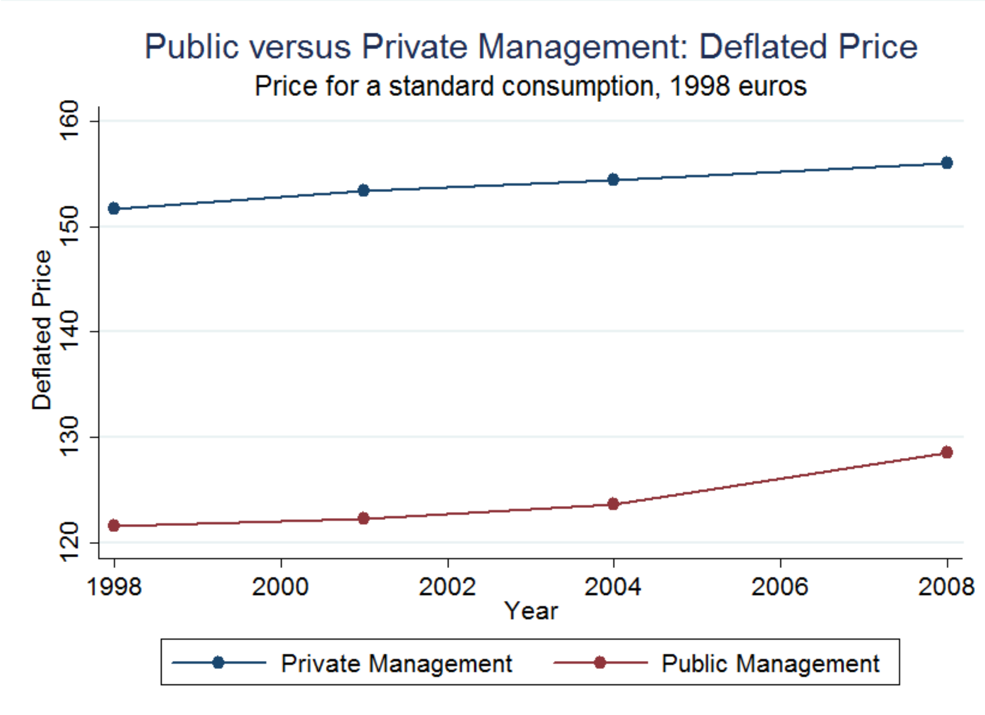
### Graphical Analysis

This subsection analyzes water price evolution under public and private management in France between 1998 and 2008. Although our ultimate objective is to measure the real impact of private sector participation on prices, the graphs depicted here show the gross difference and evolution of prices between public and private management. Moreover, results are of independent interest in that they provide a comprehensive assessment to date of the magnitude and timing of price differences.

Figure 1.1 depicts the evolution of the price of a standard bill between 1998 and 2008. The dark line represents price under private management and the light line scatters price under public management. All prices are deflated at the 1998-level. The gap between public and private management remains almost constant at 30 euros. We only observe some slight convergence between 2004 and 2008.

Figures 1.2 and 1.3 show the evolution of the price of a standard bill between 1998 and 2008 in municipalities switching from an organizational type to another. Figure 1.2 shows the evolution of price under public management between 1998 and 2008 (solid line, circle markers) and for municipalities switching from public to private management between 1999 and 2001 (dash-dot line,

Figure 1.1: Price Evolution under Public and Private Management




triangle markers), municipalities switching between 2002 and 2004 (dot line, square markers) and municipalities switching between 2005 and 2008 (dash-dot-dot line, plus markers). We observe that municipalities switching from public to private management have a tendency to increase price faster than municipalities remaining under public management for the whole period. Municipalities switching between 2002 and 2004 experience a large increase in price by 2004 but this tendency is counterbalanced between 2004 and 2008. Municipalities switching between 2005 and 2008 experience an increase in price that is similar that in the non-switching municipalities. Overall, only municipalities switching between 1999 and 2001 clearly demonstrates how switching to private management can increase price for two reasons. First, we observe price evolution after switching on a longer time period. Second, the price evolution between 1998 and 2001 is strongly similar and validates the positive impact of a switch in prices for the remaining period. For municipalities switching in 2004 and 2008, the graphical analysis is not conclusive.

Figure 1.2: Prices Evolution in Cities under Public Management that Switched to Private Management

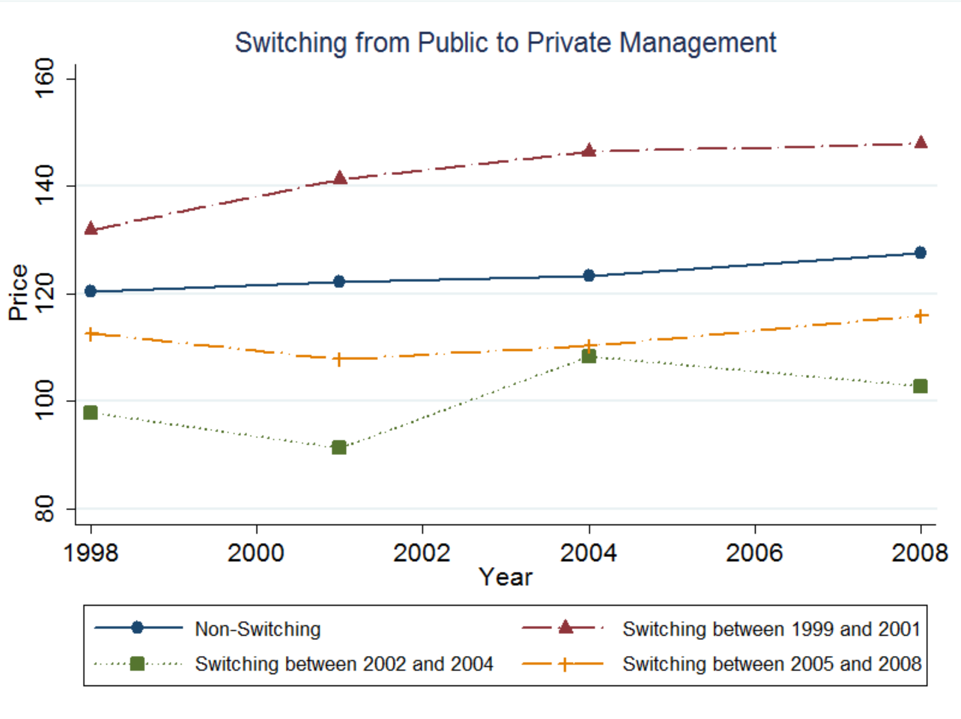



Figure 1.3: Prices Evolution in Cities under Private Management that Switched to Public Management

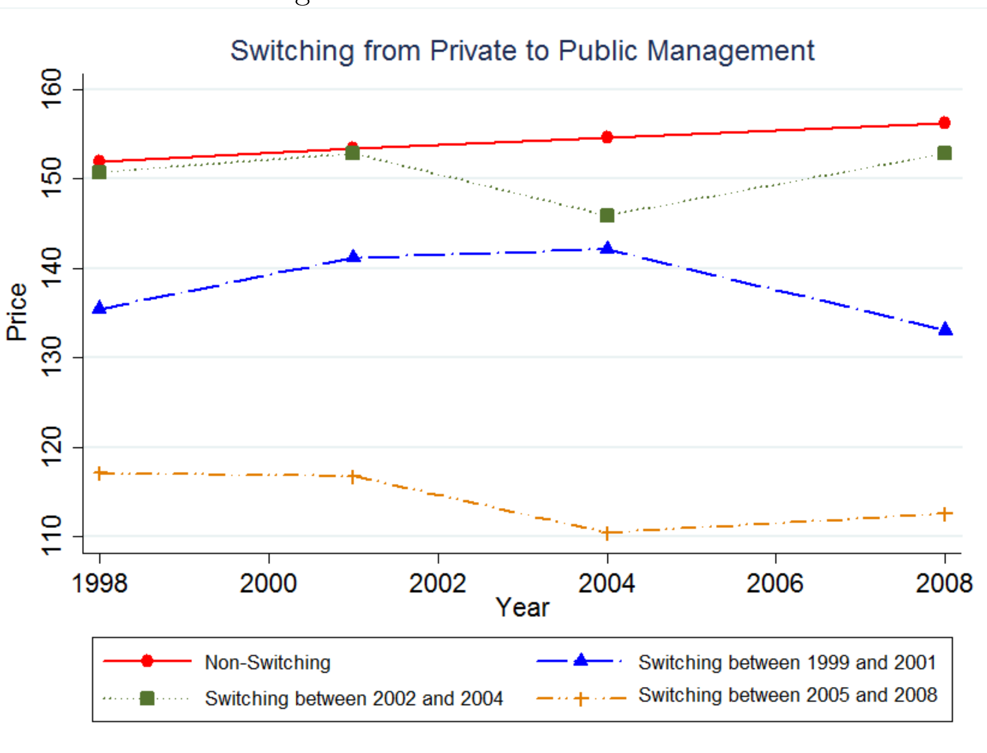


Figure 1.3 shows the evolution of price under private management between 1998 and 2008 (solid line, circle markers) and for municipalities switching from private to public management between 1999 and 2001 (dash-dot line, triangle markers), municipalities switching between 2002 and 2004 (dot line, square markers) and municipalities switching between 2005 and 2008 (dash-dot-dot line, plus markers). We observe that municipalities switching from private to public management between 1999 and 2001 have a tendency to lower prices after switching management. Municipalities switching between 2002 and 2004 experience a decrease in prices by 2004 but this tendency is counterbalanced between 2004 and 2008. Municipalities switching between 2005 and 2008 experience a decrease in prices but the tendency is prior to the switching. Prices even increase between 2004 and 2008. As in the previous graph, only municipalities switching between 1999 and 2001 provides a clear argument supporting the fact that switching to public management lowers price for two reasons. For municipalities switching in 2004 and 2008, the graphical analysis is not conclusive because prior tendencies are not always similar. We study more deeply these price evolutions in the next sections.

## 1.4 Empirical Strategy

### The Impact of Private Participation on Prices

Our objective is to identify the average effect of private participation on the price of a standard bill of residential water use. We are specifically interested in comparing prices for a standard bill when water services are privately operated (our treatment group) compared to directly managed water services (our control group) at the same moment in time. To control for the unobserved heterogeneity and the unobserved time invariant heterogeneity we include *Département* fixed effects, time fixed effects and robust standard errors. We run alternatively a simple OLS model or a fixed effects model that takes the form of the following equation:

$$Price_{it} = \alpha_0 + \alpha_1 Private_{it} + \gamma\Theta_{it} + \eta_{it} \tag{1.1}$$

with the marginal price $Price_{it}$ as a dependent variable, $Private_{it}$ a dummy that equals 1 when water is distributed by a private operator and $\Theta_{it}$ a set of controls[16] that can shift prices. The results from this model are reported in Table 1.3.

Model (1) in Table 1.3 is a simple OLS regression. It shows the mean price difference between private and public management when we take into account all controls. While the gap between average prices is 30 euros, accounting for various characteristics of the municipality lowers it to 22 euros. Model (2) runs the same model but includes the lagged price. The price gap between public and private management is now 7.30 euros. This model gives a closer result of what a municipality could expect by switching from public to private management. One of the drawbacks of this simple approach is that it is often serially correlated and it does not control for omitted variables at the municipal level. However, it offers a lower bound of what can really be the impact of private management on prices.

[16]Price is deflated using 1998 prices in euros. Control variables are water sources fixed-effects, water treatments fixed-effects, year fixed-effects, *département* fixed-effects, population in log, a dummy for the touristic nature of the city, a dummy whether cities regrouped in a pool of cities to provide public services, a dummy if there is a limitation because of scarcity, a dummy if there is an investment program. We also include three continuous variables. The first one is the independence of the city regarding water measured as the ratio between water imports and billed water. The second one is network performance measured as the ratio between billed water and billed water plus leaks. The last one is consumption density, calculated as the ratio between daily billed volumetric charge of water and the length of the pipes.

Table 1.3: The Impact of Private Management on Prices

| Model<br>Variables | (1)<br>**OLS**<br>Price | (2)<br>**OLS**<br>Price | (3)<br>**Within-FE**<br>Price | (4)<br>**AR(1)-FE**<br>Price |
|---|---|---|---|---|
| Private Management (=1) | 22.34*** | 7.307*** | 9.010*** | 8.954*** |
| | (0.875) | (0.889) | (1.988) | (2.137) |
| $\text{Price}_{t-1}$ | | 0.744*** | | |
| | | (0.0359) | | |
| Consumption Density | -0.361*** | -0.116*** | -0.0756** | -0.108** |
| | (0.0319) | (0.0303) | (0.0295) | (0.0455) |
| Independence | -9.028*** | -2.272 | -7.870*** | 2.638 |
| | (2.012) | (1.590) | (3.020) | (2.754) |
| Network Performance | -2.227 | -7.965*** | -1.298 | -5.126* |
| | (3.725) | (2.961) | (3.384) | (2.852) |
| Ln(pop) | -4.036*** | -1.170*** | -12.11* | -7.781 |
| | (0.301) | (0.297) | (6.461) | (4.881) |
| Limitation (=1) | -0.836 | 0.848 | -1.215 | -1.748* |
| | (1.673) | (1.145) | (1.052) | (0.970) |
| Investment Program (=1) | 2.671*** | 0.432 | -0.792 | 0.329 |
| | (0.908) | (0.595) | (0.590) | (0.605) |
| Touristic Area (=1) | 1.872 | 0.763 | 4.395** | 3.941* |
| | (1.245) | (0.967) | (2.198) | (2.108) |
| Pool of cities (=1) | 12.06*** | 1.292 | 10.77*** | 6.850*** |
| | (1.147) | (1.090) | (1.693) | (1.898) |
| Ground Water (=1) | 19.82*** | 4.433*** | 1.999 | 8.291*** |
| | (2.123) | (1.225) | (3.745) | (2.740) |
| Mixed Water (=1) | 4.645*** | 2.093** | -0.0215 | 3.927** |
| | (1.346) | (0.981) | (1.950) | (1.862) |
| Treatment 2 (=1) | -0.0343 | 4.094 | -4.901 | -14.01** |
| | (13.94) | (3.038) | (13.21) | (6.392) |
| Treatment 3 (=1) | 5.394 | 3.778 | 0.604 | -13.75** |
| | (14.46) | (3.144) | (13.54) | (6.566) |
| Treatment 4 (=1) | 6.962 | 3.926 | -2.533 | -14.73** |
| | (14.73) | (3.283) | (14.51) | (6.595) |
| Treatment 5 (=1) | 6.744 | 3.677 | -4.263 | -14.80** |
| | (14.91) | (3.451) | (15.05) | (6.711) |
| Treatment 6 (=1) | 9.938 | 5.842* | -3.768 | -14.46** |
| | (14.47) | (3.346) | (13.65) | (6.687) |
| Constant | 160.8*** | 44.11*** | 235.5*** | 211.8*** |
| | (19.43) | (9.425) | (49.48) | (27.29) |
| Year FE | Yes | Yes | Yes | Yes |
| Regional FE | Yes | Yes | | |
| Cities FE | | | Yes | Yes |
| Observations | 9,820 | 7,365 | 9,820 | 7,365 |
| R-squared (Within if FE) | 0.427 | 0.759 | 0.030 | 0.018 |
| Number of Groups | | | 2,455 | 2,455 |

Note: The dependent variable is the price for a standard bill of water for a given municipality. Model (1) is an OLS regression using the full sample. Model (2) is model (1) including the lagged price. Model (3) is a within fixed-effects regression. Model (4) performs an auto-regressive model with fixed-effects. Robust Standard Errors in Parentheses with *** p<0.01, ** p<0.05, * p<0.1 for all models except model (4) that features standard errors.

Alternative approaches to standard regression include fixed effects that are designed to study the causes of changes within a municipality. This model controls for all time-invariant differences between municipalities. Fixed effects cannot be used to investigate time-invariant causes of the dependent variables. Time-invariant characteristics of the individuals are supposed to be perfectly collinear with the entity dummies. As a result, we expect the impact of private management to be lower under fixed-effects than with cross-sectional estimates such as model (1). This is the case in model (3) in Table 1.3 where the impact of private management is 9.01 against 22.34 in model (1). This coefficient is however susceptible to attenuation bias from measurement error: first, because management type is likely to be persistent over time and second, because small changes in management type can drive up the coefficient of the impact of private management on price. If private management is considered as a treatment effect, then the coefficient of the fixed effects model are too strong and are considered as the upper bound of the real impact of a change to private management. Model (4) shows the results of the fixed effects model when one controls for serial correlation. We assume a simple cross-sectional time-series regression models when the disturbance term is first-order autoregressive. We find a 8.95 euros premium of private management on price. The AR(1)-FE coefficient is in the bound of models (2) and (3).

There are however several assumptions that should be made in order to correctly interpret $\alpha_1$ in equation (1.1) as Galiani et al. [2005] noticed. The first assumption is that price in municipalities under public management is an unbiased estimate of the counterfactual - i.e. that it represents the price in municipalities under private management if water services were directly managed. The second assumption is that there are no unobserved characteristics that can affect both prices and the decision to outsource. We include in equation (1.1) several regressors that can take into account this concern and we discuss in 1.5 an example of missing variable. As a result, the coefficient in front of the private management is less likely to be correlated with location-specific or time-varying unobserved shocks. In subsection 1.4, we discuss the micro-validity of our estimation by focusing on municipalities that switched from public to private management and vice-versa.

Another concern is that the average impact of private management may not be homogeneous across municipalities. In this case, our estimation in equation (1.1) can be biased. One of the assumptions underlying the interpretation of the coefficients of equation (1.1) is that municipalities under public and private management are similar. Including controls is a good way to purge structural differences between observations but it does not mimic a differences-in-differences approach by estimating the impact of organizational changes assuming similar trends. Moreover, different distributions of the set of regressors that affect prices can be observable within privately and directly managed municipalities, thus referring to the first issue above, that public and private management are not randomly chosen.

To conclude this subsection, model (1) in Table 1.3 gives the average difference between public and private management. Models (2), (3) and (4) give estimates that are closer to the differences-in-differences approach. By controlling for fixed-effects and omitted variables, we purge all the differences between cities except the premium of private management. This gives a good proxy of the impact of organizational changes on price. In the following section, we discuss the possibility of pairing cities with similar characteristics to assess the impact of private management.

We face two issues. The first one is that private and public management are not randomly assigned to municipalities. The choice to delegate water production and distribution can be linked to some trade-offs between efficacy and the city's capacity to provide water. As a matter of fact, private operators often argue that differences in prices result in different difficulties in providing water. The second issue is related to the first one. As the counterfactuals are never observed, we have to build them using non-experimental methods that mimic them under reasonable conditions[17]. A major concern that lies in the first issue is that the choice to delegate water production and distribution may not be random, and that differences between municipalities could be correlated with differences in prices. In principle, a large part of the characteristics that may confound identification are those that vary across municipalities but are fixed over time.

Dealing with selection can lead to two strategies. The first one is the classical instrumented variable regression but one needs to have strong instruments which is difficult and rare. We discuss some potential instruments in 1.5. The second one is to consider some characteristics of the municipalities that can affect the decision to go for private or public management. Municipalities with the same characteristics should have the same price. These characteristics are thus linked to the outcome and to the organizational decision. Only the treatment can explain the price gap between cities that share the same characteristics. In order to approach a randomized experiment, we used a propensity score matching method to ideally pair privately-managed

[17] Heckman and Hotz [1989] on differences-in-differences show that when the secular time trends in the control treatment municipalities are the same in the pre-intervention periods then it is likely that they would have been the same in the post-intervention period if the treated municipalities had not turned to private management. This is however difficult to implement with our dataset as we observe organizational forms for given years with municipalities that turned to private management years ago.

municipalities with publicly-managed municipalities that have similar observable attributes. This method deals with the biases underlined earlier. First, conditional on the observed variables $\theta_{it}$, the matching is done on the basis of the propensity score, i.e. the probability of being privately managed, following Heckman et al. [1998]. Instead of aiming to ensure that the matched control for each participant has exactly the same values of $\theta_{it}$, the idea is to compare individuals who have the same or a similar probability of being in the treatment group. This is done in two steps. The first step is a Logit of the probability of being privately managed on different characteristics. We thus run the following Logit model linking the probability of being privately managed and the observable characteristics:

$$Private_{it} = \gamma\theta_{it} + \epsilon_{it} \tag{1.2}$$

The propensity score is the predicted value that you get from the first step. This value is then used to match comparable municipalities given their propensity score depending on the observable characteristics, i.e. $P(\theta) = Pr(Private = 1|\theta)$, to estimate the mean difference between public and private management. The distribution of the propensity scores is showed in figures (1.4) and (1.5). Matching treated and control units is made using a standard Kernel density. When there is a lot of comparable units, Kernel matching gives more accurate estimates. Indeed, Kernel density matches units using a bandwidth while other methods match units one by one.

As Angrist and Pischke [2009] noted, a question that arises when one uses matching models is how to best modelize and estimate the propensity score or how much smoothing or stratification to use when estimating $E[Y_i|p(X_i), D_i]$, especially if the covariates are continuous. The regression analog of this question is how to parametrize the control variables. As propensity score matching

Figure 1.4: Propensity Score Distribution for Control Units

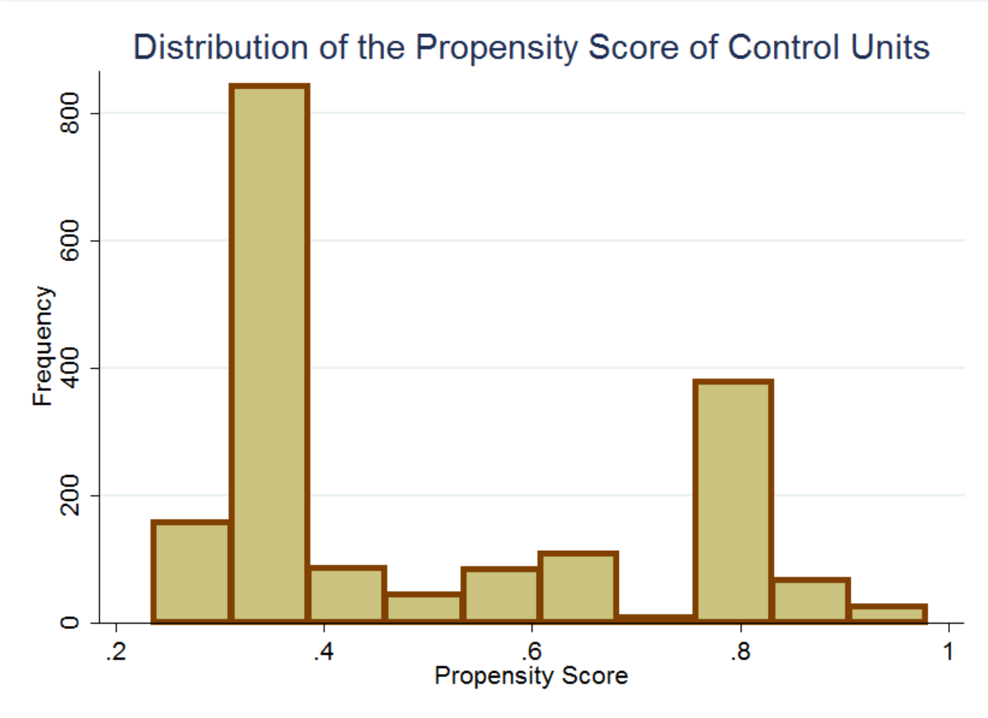
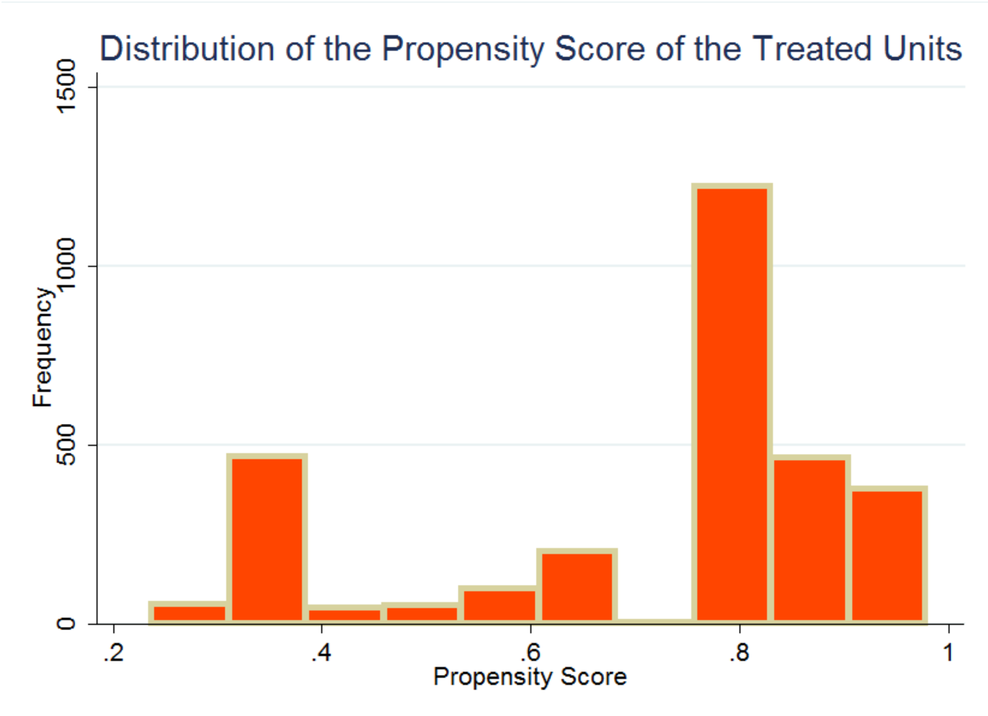



Figure 1.5: Propensity Score Distribution for Treated Units



lacks theorems and clear rules, the answer is application-specific. Dehejia and Wahba [1999] argue that a Logit model with a few polynomial terms in continuous covariates works well. Caliendo [2006] argues that one can change the propensity score model to improve the balancing of variables. They propose to include higher order terms and interactions and to re-run different equations until the overall matching is of good quality.

Results are reported in Table 1.10 in appendix at the end of this chapter. The impact of private management is 30 euros and is larger than the impact in Table 1.3. It gives however the upper bound of the marginal impact of private management and corrects upwards a part of the gross difference in marginal prices between public and private management.

Tables 1.11 and 1.12 in appendix show bias reduction in the propensity score matching. In Table 1.11, we check the selection bias for each variable included as a criterion for the matching process. Bias reduction has been decreased by more than 75% for each variable. All the t-tests reject the null-hypothesis of different means between treatment and control groups at the 0.05 threshold. Treated units are compared with control units that have on average the same characteristics as Table 1.12 shows. The mean bias is 1.8% after matching while the unmatched sample compares utilities with a 34.1% bias on average. The Pseudo-$R^2$ is close to 0 after the matching. It means that variables used in the selection equation do not explain anymore differences in management types anymore. Compared units are thus unbiased regarding the variables of the selection function. For units sharing the same characteristics used in the selection equation, we can conclude to a price premium of 30 euros when the water service is outsourced.

These results are however upward biased for several reasons. Propensity score matching is associated with a trade-off between bias and estimation efficiency. One of the drawbacks of this method is that it assumes no selection bias based on unobserved characteristics, i.e. it is not possible to include fixed effects that could alter the impact of the treatment variable. Moreover, reducing bias can lead to drop variables such as the regional fixed effects from the selection equation. This can alter estimation efficiency. However, propensity score matching can be a very powerful instrument as it helps the researcher to determine the region of common support more precisely.

We finally use the propensity score matching from equation (1.2) to restrict the sample on the common support and re-run the differences-in-differences equation (1.1). As Crump et al. [2009] noticed, an important concern in implementing matching methods is the need for overlap in the covariate distributions in the treated and control subpopulations. Even if the supports of the two covariate distributions are identical, there can be parts of the covariate space with limited numbers of observations for either the treatment or control group. Such areas of limited overlap can lead to conventional estimators of average treatment effects being biased or having large variances. There are several possibilities for researchers to reduce the support. Researchers often discard units for which there are no close counterparts in the subsample with the opposite treatment. The other means is to drop units with extreme values of the propensity score. Crump et al. [2009] propose the range [0.1,0.9] for the propensity score. Figures 1.4 and 1.5 depict the density of the propensity score for the treated and control groups. As one can see, none of our observations receives a propensity score lower than 0.2. 80% of the units have a propensity score between 0.35 and 0.91. We choose to focus on this subsample to re-run regressions[18].

[18] We could alternatively focus on ranges of the propensity score that have balanced densities of treatment and control groups. There is no clear theory about how to select the appropriate reduced support.

We consider municipalities that have propensity score between 0.35 and 0.91 as there is a fairer distribution of control and treatment groups within this interval. The results are shown in Table 1.4. The main impact of private management on price is similar to those in Table 1.3. However, as the propensity score matching result indicates, the magnitude of private management is a little upward under the reduced support. Even if some of the observables of the municipalities may not be the same at the bottom and at the top of the distribution of the propensity score, running estimations on the common support surely gives the most faithful impact of private management on marginal price. Moreover, as results in Table 1.3 may be biased by the differences in observable characteristics while results in Table 1.10 assume no unobserved differences, the results in Table 1.4 are a trustworthy estimate of the real impact of private management on price for at least three reasons. First, it takes into account the fixed differences not related to the management form. Second, it focuses on a sub-sample that have similar propensity to be privately managed. Third, the representation of privately and publicly managed municipalities is fairly balanced.

### Micro-validity: Focusing on Switchers

As Masten [2002] underlines, an organizational form that is superior will always result in large efficiency gains compared to how the same unit would have performed under the other alternative. Such a counterfactual is better approached by utilities switching from an organizational form to another[19]. The aim of this section is not to understand why municipalities switch from an organizational form to another but rather to properly measure the impact

[19] We discussed in the graphical analysis above the similarity in outcome trends before the switch. Moreover, for municipalities under private management, this is almost intuitive that price would increase in a similar trend as all contracts include an escalator clause for prices.

Table 1.4: The Impact of Private Management on Price: Reduced Support

| Model<br>Variables | (1)<br>**OLS**<br>Price | (2)<br>**OLS**<br>Price | (3)<br>**Within-FE**<br>Price | (4)<br>**AR(1)-FE**<br>Price |
|---|---|---|---|---|
| Private Management (=1) | 21.67*** | 7.953*** | 10.41*** | 9.955*** |
| | (1.105) | (1.070) | (2.529) | (2.543) |
| $Price_{t-1}$ | | 0.734*** | | |
| | | (0.049) | | |
| Consumption Density | -0.334*** | -0.0950*** | -0.0891*** | -0.0835 |
| | (0.0346) | (0.0322) | (0.0279) | (0.0569) |
| Independence | -6.576*** | -2.507 | -9.221*** | 1.473 |
| | (2.289) | (1.760) | (3.118) | (3.153) |
| Network Performance | -0.860 | -11.33*** | -3.627 | -7.506** |
| | (4.754) | (3.751) | (4.540) | (3.586) |
| Ln(pop) | -4.497*** | -1.338*** | -16.83** | -10.51* |
| | (0.348) | (0.381) | (7.581) | (5.664) |
| Limitation (=1) | -1.493 | 0.818 | -1.294 | -1.429 |
| | (2.026) | (1.332) | (1.274) | (1.143) |
| Investment Program (=1) | 3.424*** | 0.330 | -1.321* | 0.0770 |
| | (1.100) | (0.695) | (0.677) | (0.726) |
| Touristic Area (=1) | 0.169 | -0.919 | 6.078 | 4.619 |
| | (1.702) | (1.389) | (3.731) | (2.926) |
| Pool of cities (=1) | 11.39*** | 1.340 | 13.41*** | 8.779*** |
| | (1.422) | (1.392) | (1.853) | (2.181) |
| Ground Water (=1) | 19.12*** | 6.459*** | -0.556 | 9.328*** |
| | (2.676) | (1.479) | (4.776) | (3.192) |
| Mixed Water (=1) | 3.590** | 2.889** | 0.450 | 4.646** |
| | (1.568) | (1.124) | (2.289) | (2.201) |
| Treatment 2 (=1) | -14.87 | 4.114 | -15.72 | -16.85** |
| | (26.41) | (5.088) | (22.05) | (8.150) |
| Treatment 3 (=1) | -10.99 | 2.553 | -11.34 | -18.77** |
| | (27.21) | (5.213) | (22.46) | (8.313) |
| Treatment 4 (=1) | -10.22 | 2.874 | -14.29 | -19.82** |
| | (27.55) | (5.342) | (23.61) | (8.344) |
| Treatment 5 (=1) | -11.27 | 1.949 | -17.76 | -21.25** |
| | (27.69) | (5.503) | (24.32) | (8.482) |
| Treatment 6 (=1) | -6.482 | 5.666 | -16.03 | -18.28** |
| | (27.20) | (5.428) | (22.56) | (8.443) |
| Constant | 191.7*** | 61.20*** | 286.8*** | 239.1*** |
| | (27.35) | (12.23) | (57.77) | (32.24) |
| Year FE | Yes | Yes | Yes | Yes |
| Regional FE | Yes | Yes | | |
| Observations | 7,208 | 5,406 | 7,208 | 5,406 |
| R-squared (Within if FE) | 0.437 | 0.758 | 0.036 | 0.020 |
| Number of Cities | | | 1,802 | 1,802 |

Note: The dependent variable is the price for a standard bill of water for a given municipality. Model (1) is an OLS regression using the full sample. Model (2) is model (1) including the lagged price. Models (3) is a within fixed-effects regressor. Model (4) performs an auto-regressive model with fixed-effects. Robust Standard Errors in Parentheses with *** p<0.01, ** p<0.05, * p<0.1 for all models except model (4) that features standard errors.

of switches on performance. Our identification strategy is close to the standard differences-in-differences method as developed by Card and Krueger [1994] or Gruber [1994]. We focus on switchers from public to private management and from private to public management. We apply the standard differences-in-differences model :

$$Price_{it} = \beta_0 + \beta_1 Switch_{it} + \beta_2 After_t + \beta_3 Switch_{it} \cdot After_t + \lambda\Theta_{it} + \epsilon_{it} \quad (1.3)$$

with $Switch_{it}$ a dummy that equals 1 if the city $i$ has changed its management type between 1998 and 2008, $After_t$ a dummy equal to 1 for the period after the switch and $\beta_3$ the coefficient of the standard differences-in-differences. As we have a dataset including four years, we allow $After_t$ to cover three different periods (after 2001, after 2004 and after 2008). Moreover, we can differentiate between cities switching from public to private management and those switching from private to public management. We run four regressions using OLS with city-clustered robust standard errors. Results are reported in Table 1.5. Models (1) and (3) analyze the impact of a switch from private to public management. Models (2) and (4) study the impact of a switch from public to private management. All controls from equation (1.1) are included. We did not report their coefficients as they are barely the same in previous regressions. For ease of reading, we report in the first rows the differences-in-differences coefficients. The main results are emphasized.

Model (1) focuses on the sample of cities under private management in 1998. All switchers from private to public management are compared to cities that remain under private management for the whole period. We expect the $\beta_3$ to be negative as public management should have a negative impact on price. This is the case in column (1) even if results are only significant for cities switching between 2004 and 2008. In the latter case, switching from

Table 1.5: Differences-in-differences of the impact of management change on price

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| **Switching From** | Private | Public | Private | Public |
| **to** | Public | Private | Public | Private |
| **Variables** | Price | Price | Price | Price |
| Switch 2001 · After 2001 (=1) | -6.561 | **13.96***** | -7.634 | **15.12***** |
| | (8.729) | (3.033) | (7.189) | (2.822) |
| Switch 2004 · After 2004 (=1) | -6.949 | -1.603 | -9.096 | -4.585 |
| | (11.22) | (10.69) | (10.19) | (10.53) |
| Switch 2008 · After 2008 (=1) | **-7.755**** | -1.456 | **-9.393***** | 1.824 |
| | (3.590) | (5.332) | (3.201) | (4.653) |
| Switch 2001 (=1) | -15.08* | 7.686** | -4.807 | 0.488 |
| | (8.484) | (3.493) | (5.994) | (4.031) |
| Switch 2004 (=1) | -7.779 | -11.45 | -2.378 | -33.15*** |
| | (8.565) | (8.483) | (9.898) | (6.570) |
| Switch 2008 (=1) | -16.90* | -2.773 | -3.138 | -19.41*** |
| | (10.20) | (5.727) | (7.755) | (6.338) |
| After 2001 (=1) | -0.377 | 1.201 | -0.121 | -0.437 |
| | (0.731) | (1.049) | (0.616) | (0.611) |
| After 2004 (=1) | 1.263** | 0.900 | 0.612 | 0.530 |
| | (0.640) | (0.712) | (0.486) | (0.478) |
| After 2008 (=1) | 0.442 | 2.984*** | 1.142** | 0.890* |
| | (0.643) | (0.700) | (0.492) | (0.486) |
| Constant | 198.4*** | 133.6*** | 166.3*** | 168.8*** |
| | (51.35) | (13.35) | (30.27) | (30.38) |
| All Controls | Yes | Yes | Yes | Yes |
| Observations | 6,810 | 3,064 | 9,820 | 9,820 |
| R-squared | 0.416 | 0.395 | 0.388 | 0.392 |
| Sample | Private | Public | Full | Full |

Note: All models are OLS regressions. The dependent variable is price for a standard bill of a city $i$. City-Clustered Robust Standard Errors are reported in parentheses with *** p<0.01, ** p<0.05, * p<0.1. Models (1) and (3) analyze the impact of a switch from private to public management. Models (2) and (4) study the impact of a switch from public to private management. Models (1) compares switchers relatively to non-switchers under private management. Model (3) evaluates switchers regarding non-switchers under public management. Models (3) and (4) examine switchers regarding the whole sample. A switch to public (private) management means that the municipality switched from private (public) management to public (private) management between $t$ and $t_{-1}$.

private to public management leads to a decrease in price by 7.755 euros on average. Model (3) uses as a sample the whole dataset. The control group is made of all other cities, no matter if they were under public or private management in 1998. The results are negative as in model (1) but the main impact is more important. However, this regression gives a good robustness test of model (1) as coefficient are barely the same. Results show that switching from private to public management can decrease price in the short-term but not necessarily in the long-term. This is a strong proof that differences in prices between public and private management are rather structural than linked to the organizational form itself.

Model (2) uses cities under public management in 1998 as a sample. The treatment group is made of cities switching from public to private management. Cities that remain under public management for the whole period are control units. In this case, the $\beta_3$ is expected to be positive if private management is by itself associated with higher prices. It is the case for cities switching between 1998 and 2001. However, it is not the case for cities switching between 2001 and 2004 and 2004 and 2008. The differences-in-differences is significant at 13.96 euros for 2001. Cities that experienced a management change from public to private have to deal on average with a large price premium for the remaining period. It is negative and non-significant for municipalities switching between 2001 and 2004 and between 2004 to 2008. The interpretation is twofold. It means that price change after a change from public to private management is not immediate. It also means that switching is related to a potential decrease in prices. Model (4) uses the full dataset to estimate the real impact on price of switching. We observe here results that are similar to model (2) for the first period. Switching from public to private is associated with higher prices. However, for the next periods, switching from public to private is not associated with significant increasing prices. Indeed, the gain from switching is about 15.12 euros in 2001. The $\beta_3$ is positive but not significant for 2008 and negative and non significant for 2004. It indicates that switching from public to private does not lead to higher price on average in the most recent time periods. This can be interpreted as the result of inertia in long-term contracting. Prices tend to increase after several years when a city switched from public to private management.

The impact of organizational change on performance has rarely been studied empirically in scientific articles. A recent paper by Chong et al. [2012] studies the reason for switching - and not the impact of switching - from public (private) to private (public) management using the same dataset as in this paper. They conclude to a switch from private to public management when there is scope for improving efficiency, measured by potential price decrease for a typical bill[20]. The authors build counterfactual price of water by regressing price on a set of observables. They identify the degree to which each municipality is “overpaying” or “underpaying” under its current organizational form, and compared to the alternative organizational form. Other controls, such as political bias from mayors or switches in mayors have no impact. Results differ between large and small municipalities, small municipalities being less sensitive to efficiency gains. They find that large municipalities respond to excessive prices by switching provider or organizational form. Overall, cities switch to the form that is expected to be the lowest-price form. They interpret the results as evidence that large municipalities’ ability to constrain franchiser opportunism rests on its ability to credibly threaten to bring service in-house and to promote competition when contracts are to be renewed. Overall, our results add to those of Chong et al. [2012]. Switching from private to public management decreases price. Switching from public to private management potentially decreases price in the last periods, even if the effect is not significant.

[20]Their conclusion is somewhat close to the one of Nickerson and Silverman [2003] who study the link between transaction and organization on the one hand, and on the other hand, the link between alignment of the organization to the transaction and performance.

How much then can we trust the robustness of our estimations? Focusing on switching municipalities gives a micro-validity to the main argument that private participation leads to higher prices. Two interpretations can be made. The first one is that contracting-out leads to increasing prices over time. Cities switching from public to private management between 1998 and 2001 are observed during a longer time span and are associated with higher prices. Another reason is that competition has increased between 1998 and 2008. Cities contracting out in 2008 can benefit from lower prices, what was not the case in 2001. However, there are also some limits to our results. We miss a set of variables that could explain the amplitude of price evolution after a switch. One might argue that changes in prices are related to the level of competition during the bidding process. In this case, the impact on price of a switch may also be related to the number of bidders or to the relative level of bids between the incumbent and competitors. However, our estimations are interesting because they give a precise idea of the counterfactual price under another organizational form using real-life data.[21]. A similar methodology is used in Hastings [2004] to study the impact on gasoline retail price of competing stations after a merger between a gas retailer and an integrated refiner-retailer and more recently, in Ashenfelter and Hosken [2010] to estimate the likely price effect of five completed mergers in the United States.

Using differences-in-differences is justified for several reasons. First, it shows the impact of staggered management changes throughout the period. Secondly, standard models as equation (1.1) evaluate only private management relatively to public management. The differences-in-differences approach focuses on switchers relatively to their control group at the beginning of the time

[21]See the debate between Angrist and Pischke [2010] and Nevo and Whinston [2010] for more information on credible exogenous variables and research design in industrial organization.

period. The present results thus mitigate previous results overall concluding to a positive impact of private management on price. There is however at least one drawback to our results. As we do not control for endogeneity, decision to change can be endogenous if they are linked to bids or to price evaluation made by the municipality, as Chong et al. [2012] studied. We discuss in the next section limits to our findings.

## 1.5 Discussion, Extension and Methodological Implications

In this section, we discuss the previous results regarding possible omitted variables. We also list several explanations for the price-gap between public and private management. We then extend the analysis of the previous section by including endogeneity considerations. We finally tackle the methodological implications of our work.

### Discussion of Possible Explanations

Private companies may show higher prices than public management because management structure affects pricing. But it may also be the case that the management variable is spuriously capturing the effect of another variable correlated with it. Despite controls for selection and market-based analyses, difficulties remain to explain the price-gap between public and private management. Five reasons are often pointed out by the literature but few empirical tests clearly quantify their impact.

The first reason is competition. Regional or sector-level competition is an usual argument to explain differences in prices between public and private management (see for example Borenstein and Rose [1994] on airline industries or Joskow [2005] for a global perspective): high margins are the result of low competition-intensity due to the nature of the market, i.e. local monopolies protected by a contract. When there is no national regulator as in France (see above), margins are highly related to the ability of the municipality to negotiate with the private operator. Nevertheless, global margins remain low[22] in France, far below the difference in rates between public and private management. Pricing strategies are usually based on previous prices for at least two reasons: first, because prices are fixed to cover previous costs, no matter if there is room for cost-efficiency, and second because a given level of price gives the quantity at which market clears. One of the reasons why private management has higher prices is that contract renewals are based on previous prices and thereby maintain the price gap between public and private management. An increased competition at the renewal generally lowers prices [23]. The bidding process at the end of the contract can itself create competition and thus price decreases.

Because of a lack of longitudinal data on water contracts, there are few studies which focus on contract renewals. In France, Guérin-Schneider and Lorrain [2003] examined contract renewals between 1998 and 2001 and found that renewals were usually associated with decreasing prices (-10% on average). Increased competition, measured as ending contracts, can thus provide lower prices. The results suggest also that prices are set too high, as a result of extra-margins before renewals or inefficient cost structures.

As we have neither information on bids or geographical competition in our dataset, we use incumbents' renewals as a proxy for competition. In nat-

[22]See Porcher [2012b] for a study of margins in French water industries for 2008. According to the French private operators, net margins are on average 10% before taxes.

[23]The recent case of Antibes, a city in the south of France, is probably one of the best examples. Contract renewal with the same operator led to a 40% decrease in price. A private competitor bade at a 30% lower price.

ural monopolies such as water provision, we can expect low competition to have a negative impact on consumers (Coase [1946]) or to be associated with a low-monitoring efficiency of the principal (Laffont and Tirole [1993]). Table 1.6 shows the impact of the bidding process on price. The model is similar to equation (1.3). For ease of reading, the first rows of Table 1.6 report coefficients of the differences-in-differences. The control group is cities under private management in 1998. The $Switch_{it}$ variables are dummies that take 1 if the city $i$ switches from an operator to another at a given year $t$. The $Renew_{it}$ variables are dummies that take 1 if the city $i$ renews its contract with the same operator at year $t$. Table 1.6 shows that switching is associated with lower prices. However the coefficient for the differences-in-differences is only significant for cities switching in 2004. The magnitude of the impact is however important and larger than a switch from private to public management (the maximum is 24.30 euros here against -9.39 euros in Table 1.5). Renewals have a negative significant impact in 2001 and 2008 but a positive significant impact in 2004. The impact is smaller than under a switching hypothesis. The gain is 4.12 euros in 2001 and 8.10 euros in 2008. Overall, it seems that the bidding process has a negative impact on prices as switching and renewing contracts lead on average to lower prices. The bidding process acts as a realignment of price from the previous long-term contract.

The second reason is that the management variable may be capturing changes in quality. This is consistent with the general debate on privatization. Critiques of private management often argue that it leads to increased prices at the expense of society (see Vickers and Yarrow [1988] for a discussion) while proponents argue that increased prices result in large productivity gains (see La Porta and López-de Silanes [1999] for a comprehensive study). In regulated industries, proofs of efficiency gains for electricity in the United States are discussed in Fabrizio et al. [2007]. In our previous regressions, we systematically controlled for network performance. Another control can be

Table 1.6: Differences-in-differences for Private Firms Switching Operators and Contract Renewal

| Model Variables | (1) OLS Price |
|---|---|
| Switch 2001 · After 2001 (=1) | -2.188 |
| | (5.857) |
| Switch 2004 · After 2004 (=1) | **-24.30*** ** |
| | (5.815) |
| Switch 2008 · After 2008 (=1) | -2.500 |
| | (3.854) |
| Renew 2001 · After 2001 (=1) | **-4.119*** |
| | (2.136) |
| Renew 2004 · After 2004 (=1) | 3.766* |
| | (2.273) |
| Renew 2008 · After 2008 (=1) | **-8.104*** ** |
| | (1.529) |
| Switch 2001 (=1) | -7.110 |
| | (6.332) |
| Switch 2004 (=1) | -2.904 |
| | (7.480) |
| Switch 2008 (=1) | -7.279 |
| | (4.554) |
| Renew 2001 (=1) | 1.527 |
| | (2.584) |
| Renew 2004 (=1) | -6.637** |
| | (2.706) |
| Renew 2008 (=1) | -5.439*** |
| | (1.815) |
| After 2001 (=1) | 0.235 |
| | (0.780) |
| After 2004 (=1) | 1.096* |
| | (0.663) |
| After 2008 (=1) | 2.058*** |
| | (0.746) |
| Constant | 215.0*** |
| | (49.42) |
| All Controls | Yes |
| Observations | 6,810 |
| R-squared | 0.418 |

Note: City-Clustered Robust Standard Errors in Parentheses with *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is price for a standard bill. Switchers are cities that keep their public water service outsourced but switch from an operator to another. Contract renewal means that the incumbent is renewed to manage the public water service. All comparisons are made regarding cities that have private management in 1998.

water quality. The reason why we did not control for water quality is twofold. Firstly, water quality in France has been largely achieved since the 1995 water act. Secondly, we have only data for the tests carried out by the Health and Environment Ministry while a number of tests are also conducted at the local level or by the utilities themselves. As one can see in models (1) and (2) of Table 1.7, private management is on average associated with a quality premium of 2.2%. In model (2), we observe the potential quality change from a switch to private management. The quality change is evaluated to be 1.2%. Finally, in model (3) we present an OLS model to analyze the link between the number of failed quality controls and management type. Private management is associated with a higher number of failed controls but the coefficient is not significant. However, the number is quite low regarding the highest number of controls made on privately managed utilities. As far as price and final quality are related, pricing strategy may reveal differences in how managers care about quality. Public managers care more about price levels because their competitive advantage is the capacity to provide water at low price. Private managers have more experience in providing good water quality at the risk of higher price. This is however a limited result as quality is largely regulated and depends on the raw quality of the water source.

The third reason is partly linked to the second. Public and private organization may not reflect the same goals. Such a link between ownership and strategy is early discussed in Williamson [1963] who considers that managers can have expense preferences that are discretionary. Porter [1990] notices that "company goals are strongly determined by ownership structure, the motivation of owners and holders of debt". Public and private management may want to use pricing strategy to indulge their consumption preferences. For example, public managers may want to decrease prices for consumers and fund a part of its investments using taxation for bureaucratic reasons. Private managers may seek to maximize their profits to satisfy stockholders. Studies made by

Table 1.7: Controlling for Quality Differences

| Model<br>Variables | (1)<br>OLS<br>Water Quality | (2)<br>OLS<br>Water Quality | (3)<br>OLS<br>Number of "Failed" Tests |
|---|---|---|---|
| Private Management (=1) | 0.022*** | 0.012*** | 0.063 |
| | (0.005) | (0.004) | (0.085) |
| Water Quality$_{t-1}$ | | 0.590*** | |
| | | (0.030) | |
| Constant | 0.807*** | 0.359*** | -0.522 |
| | (0.036) | (0.041) | (0.454) |
| All Controls | Yes | Yes | Yes |
| Observations | 9,724 | 4,209 | 9,724 |
| R-squared | 0.216 | 0.561 | 0.127 |

Note: Observations are city-leveled. All models are standard OLS regressions. Robust Standard Errors in Parentheses with *** p<0.01, ** p<0.05, * p<0.1 for all models. The dependent variable in (1) and (2) is water quality measured as the compliance rate to the standards of water quality controls. The value takes between 0 and 1. The dependent variable in (3) is the number of water controls that do not meet the compliance rate. All controls from the previous regressions are included.

researchers in public management do not use the same methodology but find a similar results: public managers have a stronger desire to serve the public interest (Rawls et al. [1975]). These arguments are used in many studies comparing public and private ownership such as in La Porta and López-de Silanes [1999], Schargrodsky [2003] and Peng et al. [2004].

Another explanation is that private firms and public administration are not subject to the same accounting rules. A complete comparison of public and private accounting rules is far beyond the scope of this paper. However, it is clear that private firms have to depreciate their investments over the lease term. In this case, higher prices may just be the results of increased investments coupled with the necessity to depreciate the whole value of the undertaken investments. In the case of in-house provisions, the depreciation period of the investment can spread over a longer term, thus alleviating the price increase. Such an argument is trustworthy and can rationally explain the differences in fixed-fees designed to cover capital expenditures. It is however difficult to explain the existing differences between marginal prices which reflect differences in marginal costs or per-unit margins.

Finally, the incidence of the municipal water budget's debt has largely been ignored in previous research on utilities. Until 1995, it was possible for private operators to endorse a part of the municipal water debt refunding. The growing participation of private firms from the 1970s until now is probably linked to the possibility for municipalities to reject the debt burden of private firms. If one assumes that public utilities *underprice* their output, e.g. by funding investments using municipal debt rather than increasing fees, then there should be significant differences of indebtness levels between in-house and privately managed utilities. Table 1.8 gives a comparison of debt, debt per customer, debt annual payments and debt annual payments per customer for 189 large water utilities in 2009 representing more than 40% of the French population and almost 50% of the French water consumption. Water budget's debt is largely higher in municipalities under public management than in privately managed water industries as Table 1.8 shows. Actual annual repayments per customer are almost 3 euros higher under public management. Additionally, Table 1.8 provides rescheduled debt payments under alternative assumptions. For simplicity's sake, we assume that debt interest rates are fixed, at 2%, a largely validated hypothesis[24] that corresponds to what is observed in the data. Under a 5-year refund hypothesis, annual debt payments per customer would increase by 28.25 euros under public management and 17.33 euros under private management. Under this hypothesis, the remaining differences in prices between public and private management would almost be cleared-up. Under a 10-year refund hypothesis, rescheduled annual payments per customer are very close to the actual payment for public management and 4.15 euros below for private management. One can thus consider that municipalities under private management have borrowed less or for shorter terms than municipalities under

[24]State debt is on average refunded at 2.02% but only 1.3% on the short-term debt. Municipalities usually face rates at 2% in my dataset but it depends on their debt structure, i.e. whether they borrow to private or public banks or other public operators.

public management.

Assessing the impact of debt on price is not easy. Current price contains annual debt payments. Our fixed-effects regression in Tables 1.3 and 1.4 controls for the existing heterogeneity between utilities, debt including. Our argument here is that prices could increase under the hypothesis of large increase in debt interests. Such price increase and high debt levels can be distortive for consumers and producers alike. On top of that there is a risk with high-debt level that the municipality use taxation instead of market mechanisms to lower its debt. The welfare transfer between users and tax-payers could have distortionary impacts on other markets.

### Endogeneity

To properly evaluate the impact of private participation on prices, we assumed that the make-or-buy decision was exogenous. Our argument above is that such an assumption can be supported if we include enough controls for fixed effects and check robustness with regime change. Yet we run in this section alternative models including instruments that account for selecting private management.

In our empirical analysis, we assume that complexity impacts price but not the organizational form. We assume here that contracting capabilities have an impact on the organizational form. For example, municipalities that are used to contract out other public services are more keen on contracting out the water public service. As simple theoretical framework can be used to describe the impact of organizational form on price. Assume that the principal, the municipality, can choose between two organizational forms for water provision: the market $O^m$ procuring potential surplus $V^m$ or the internal production option $O^d$ giving surplus $V^d$. Under direct management, surplus is

Table 1.8: Descriptive Statistics, Extra Sample Including Water Municipal Debt

| | Public Management | Private Management |
|---|---|---|
| Water Debt (in thousands euros) | 6,599.79 | 5,858.392 |
| | (9,445.962) | (17,080.28) |
| Water Debt per Customer (in euros) | **277.0582** | **211.0306** |
| | (298.0969) | (577.4516) |
| Annual Debt Payments (in thousands euros) | 710.941 | 822.473 |
| | (1,012.309) | (2,346.025) |
| Annual Debt Payments (ADP) per Customer (in euros) | 30.525 | 27.644 |
| | (36.302) | (72.057) |
| Rescheduled ADP per Customer, under 5-year hyp. | **58.780** | **44.772** |
| | (63.244) | (122.511) |
| Rescheduled ADP per Customer, under 10-year hyp. | 30.844 | 23.493 |
| | (33.186) | (64.286) |

Note: Descriptive statistics from the complementary dataset on 189 big water utilities covering 24.3 millions inhabitants out and 1.87 billions cubic meters out of 60 millions inhabitants and 4 billions cubic meters at the national level. Debt and annual debt payments are expressed in thousands euros. Debt per customer and debt annual payments per customer are expressed in euros. Reschedules debt annual payments are computed under two assumptions: a 5-year debt refund in the fifth raw and a 10-year debt refund in the sixth raw, both under a 2% debt interest rate hypothesis.

affected by overall costs $C^d$ of production and distribution that only varies depending on complexity $i$ such as $c_i' \succ 0$. Under private management, overall costs depend also on agent's effort $e$ to reduce costs that depends on contracting capabilities $a$ of the public manager, such as $e_a' \succ 0$. Effort monitoring has however a cost c(e(a)) that is positively related to the effort. These costs cover transaction costs for example. Overall costs for producing and distributing water are $C^m = C_0 + c(e(a)) + c(i) - e(a)$ under private management while they are only $C^d = C_0 + c(i)$ under public management. Under such hypothesis, the choice to contract out the public service occurs only if $Pr(O* = O^m)$=$Pr(V^m \succ V^d)$=$Pr(C^d \succ C^m)$ i.e. if $c(e(a)) \prec e(a)$, namely if the gain of the effort is superior to the cost of monitoring the effort. Ultimately, the intuition of the model is that we expect cities with contracting experience to outsource the public service, even though the impact on price is not straightforward.

Instrumented-variable regression is not easy to implement because one needs to find good instruments that fit the robustness checks. Table 1.9 reports the results for the two-stage-least-squares (2SLS) instrumented regressors. Instruments are a dummy equal to 1 if the public sanitation service is contracted out and the ratio between exports plus imports and billed water. The latter variable is a proxy for contractual capabilities as exports are made through subcontracts with other municipalities (see Demsetz [1988] and Argyres and Mayer [2007]). The table reveals that instrumenting for contractual capabilities decreases the impact of private participation on price, as opposed to simple OLS regressions in Tables 1.3 and 1.4. The results of the first-stage are reported in columns (1) and (3) and the results of the second-stage are reported in columns (2) and (4). While in OLS regressors, the impact of private management was 22 euros, it is now 19 euros. When we consider the lagged price, we get an impact of 3.73 euros with the 2SLS while it is 7.31 with OLS. The 2SLS isolates the variation in private management that is not correlated with the error term. The coefficient under 2SLS reduces the sampling variance. Cities have different profile in contracting, depending on their capabilities. Instruments chosen here induce a self-selection as contracting-out may not be randomized.

Table 1.9: 2SLS results of the impact of private management on price

| **Stage**<br>**Variables** | (1)<br>First-Stage<br>Private Management | (2)<br>**2SLS**<br>Price | (3)<br>First-Stage<br>Private Management | (4)<br>**2SLS**<br>Price |
|---|---|---|---|---|
| Subcontracting | 0.123*** | | 0.173*** | |
| | (0.030) | | (0.034) | |
| PPP Sanitation (=1) | 0.337*** | | 0.322*** | |
| | (0.009) | | (0.010) | |
| Private Management (=1) | | 19.35*** | | 3.734** |
| | | (2.170) | | (1.771) |
| $\text{Price}_{t-1}$ | | | | 0.755*** |
| | | | | (0.0362) |
| Constant | | 116.1*** | | 37.21*** |
| | | (15.50) | | (10.62) |
| All other controls | Yes | Yes | Yes | Yes |
| Instruments | | 2 | | 2 |
| First-Stage $F$-stat | | 657.79 | | 484.77 |
| $p$-value of Hansen $J$-test | | 0.112 | | 0.850 |
| Difference-in-Sargan Stat | | Yes | | Yes |
| Observations | | 9,780 | | 7,352 |
| R-squared | | 0.718 | | 0.758 |
| Partial R-squared | 0.141 | | 0.140 | |

Note: Robust standard errors in parentheses with *** p<0.01, ** p<0.05, * p<0.1. Results of the First-stage equations are reported for the instruments. Second-stage are reported in raws (2) and (4) after the first-stage equations. First-stage $F$-stat of excluded instruments is reported. $p$-values of Hansen $J$-test are also reported. A telltale story is that a $p$-value higher than 0.25 satisfies the overidentification restriction. The orthogonality condition has been checked for both instruments.

We report in Table 1.9 several relevance and exogeneity tests of the instruments. We first take a glance at the first-stage results. We reported in column (1) and (3) the coefficients of the two instruments for the first-stage (we did not report the coefficients of the excluded instruments). As we can see capabilities in subcontracting and contracting for other public services have strong and significant impacts on the make-or-buy decision. The partial R-squared is satisfying and the first-stage $F$-stat is quite high. We also report the $p$-values of the Hansen $J$-test. $p$-values are higher than 0.11 in column

(2) and equal to 0.891 in column (4). A telltale story is that a $p$-value higher than 0.25 satisfies the over-identification restriction. The orthogonality condition has been checked for both instruments. Overall, our model is robust and provides an efficient model of the impact of private participation on price. We can include more instruments such as a proxy for production capabilities or being part of a group of municipalities, to increase the first-stage R-squared but at the possible expense of precision in the second stage. Finally, our present results are robust to the inclusion of extra-instruments.

## Methodological Implications

Manipulating big data is now a common feature of research in economics, organization and management sciences. Exploiting big data often raises questions on the robustness of data analysis and research design. A famous quote from Ronald Coase (even if he never properly wrote it) is "if you torture the data long enough it will confess". Recent Bank of Sweden Nobel Prize winner Christopher Sims recognized in the 1980s that empirical research should be based on formal specification of priors and their incorporation into an elaborate multivariate framework. Leamer [1983] views applied econometrics research papers of the 1970s and early 1980s as lacking credibility. Leamer believed that more sensitivity analysis - including control variables and fixed-effects to compare results - was needed. From the 1990s and the papers of Card and Krueger [1994] onwards, randomized experimentations became very popular. The reason is simple: they offered research designs that dropped out reverse causality.

The success of empirical analysis in economics is also relevant in strategic and organizational management. A growing management literature is based on big data analyses. Method papers such as Hamilton and Nickerson [2003] and

Bascle [2008] discuss for example potential bias from empirical research that fail to control for endogeneity. Hoetker [2007] reveals that most researchers using Logit or Probit models in Strategic Management failed at interpreting correctly the results. In this paper, we clearly discuss the benefits and the drawbacks of each model. We also propose a toolkit to make research in management more robust by using marginal change interpretation and exploit potential natural experiments. A way to make empirical results more robust is to use matching to get a subsample of comparable units.

An advantage of the propensity score matching is that it forces researchers to get into the data and to design the evaluation framework before looking at the outcomes. It focuses researchers on the design of treatment assignment rather than on the outcomes of a standard regression. This is particularly important when the treatment is designed by a human institution - here the municipal council that decides to make-or-buy - and the outcomes are uncertain, depending on market factors such as competition. Another argument made by Angrist and Hahn [1999] is that in finite samples, focusing on the propensity score excludes automatically numerous variables that explain little variation of the outcomes. Moreover, these variables may bear some statistical burdens that it is better to prevent. Selecting finely the variables to design the treatment effect avoids large equations. Other technical advantages are the use of non-parametric or semi-parametric matching techniques that tend to focus on the common support condition.

However, matching on the propensity score also presents several drawbacks. First, it is asymptotically less efficient than regression. Indeed, we can get lower asymptotic standard errors by matching on any covariate that explains outcomes, whether or not it turns up in the propensity score. Second, a regression usually gives more accurate coefficients on the variables. Third, there is a cost on matching on some variables that could explain outcomes. Fourth, it often leads to reduce the dimensionality of the matching problem in a manner that can have real empirical consequences. Fifth, modeling propensity score matching is not yet standardized.

Nevertheless all things considered, propensity score matching can be a good pre-screening estimation. Crump et al. [2009] suggest for example that the propensity score should be used as a tool for systematic sample selection before regression. In a second step, the researcher can limit its sample to observations that are in the common support or on a reduced part of the common support. For units it is difficult to find comparable units with the opposite treatment, analyses are sensitive to minor changes in the specification and lower precision of the resulting estimates. Reducing the sample using knowledge-based criteria gives stronger results for the internal validity. The main drawback is that some external validity is potentially lost by changing the focus to average treatment effects for a subset of the original sample.

Another methodological question that is raised in this article is the difference between the mean impact of the treatment and its marginal impact. We propose models that are efficient at capturing the mean impact and others that aim at isolating the marginal impact. Because of our dataset, we face two problems. The first one is that we cannot control for outcomes before and after the management change for the whole dataset. The second one is that management changes are staggered over time. These two issues make proper estimation of the impact of private management very difficult. We have two solutions. The first one is to include a lagged variable for outcome. In this case, all the difference between outcome at *t* and *t-1* is explained by the potential management change and the controls. However, all controls can be correlated with the lagged outcome and results may be biased. Another solution is to use within fixed effects models to highlight the mean impact of a management change. However, within-FE gives mean results for the variable of interest and there is always a risk that its high variance draws the coefficient upward. We suggest to focus on a subsample of observations that switched from an organization to another. Indeed, this method gives helpful results to really evaluate the impact of a variable on another, especially when one uses deep datasets covering several years. Such robustness checks on subsamples (or extra-sample) are always useful to endorse internal (or external validity) of the main implications.

## 1.6 Conclusion

In this paper, we analyzed the impact of private participation on retail price in residential water supply. We found that private management is on average more expensive for customers than public management, everything else being equal. We used econometric methods that isolates the impact of private participation on price. We then reduced our sample to utilities that have the same propensity score. We found that price are higher under private management. We then checked the micro-validity of our results using differences-in-differences for switchers. We found that cities switching from private to public management experience decreasing tariffs. We discovered that cities switching from public to private management face higher prices at the beginning of the period but not at the end of the period. This is consistent with the idea that cities change organizations or contracts when they can expect lower prices. This results is confirmed by focusing on cities switching from an operator to another while remaining under private management. Cities renewing the incumbent at the end of the contract usually experience decreasing price after the renewal. We also discussed potential reasons for the price-gap between public and private management. Water budget debt is a possible explanation for the evolution of price. We finally instrumented private management using proxies for contractual capabilities and obtained results that are consistent with the previous ones.

Broadly speaking, the price difference on a bill of 120 cubic meters of water is rather small, between 3 and 10 euros on average per year, for an average price of 144 euros. We think that advocates of private management may be surprised to learn that our best estimate of the price effects of private management are positive, not negative as it would have been the case if private management were operating in cities that are structurally more difficult. Likewise, we believe that some advocates of more public intervention may be surprised to learn that public management is not associated with huge price gaps and neither is more performance.

Our research carries several policy implications. First, municipalities must be aware that switching from a management form to another will impact their prices, but not in the direction they expect. Structural reasons are probably more robust at explaining price than organizational choice itself. Second, comparing municipalities between one and another imposes a reasonably similar sample in terms of observables. Third, switching is costly. It demands to public managers strong organizational capabilities and a lot of financial resources to buy some fixed assets to the former operator.

Our results have several limitations. First, our paper studies difference in performance between public and private management between 1998 and 2008 but can fail to explain price differences in the coming years, as our data does not allow us to take into account competition intensity. Second, we are not able to account for the potential long-term effect of organizational change on performance. Our results suggest that long-term difference in price is not always significant. We lack indicators of debt and capital output investments to properly measure the supposed long-term performance of a switch and of a renewal.

We also think that our results pave the way for much further research. First, it seems that the evaluation and the study of organizational changes is in its infancy. In view of the extensive use to which these models are put, a careful evaluation of their effectiveness needs to be done. Second, future research in economics and management could exploit such changes in organization, firm boundaries and ownership to question models interpretation and comparing results using different methods, including structural econometrics. We attempted to give some pathways to stronger methodological design such as the use of reduced samples to comparable observations and the focus on micro-validity. The broader conclusion of the paper is that we need more real-life data to assess the impact of organizational choices on market performance and structure. For public utilities, collecting data on costs and fixed assets could give us a more complete picture of the public-private management comparison. Future research could use costs and stakeholders perception as an output of organization.

# Appendix

Table 1.10: The Impact of Private Management on Prices

| Model<br>Variables | (1)<br>**Logit**<br>Private Management | (2)<br>**Kernel Matching**<br>Price |
|---|---|---|
| Private Management (=1) | | 31.78*** |
| | | (1.550) |
| Urban (=1) | 1.145*** | |
| | (0.103) | |
| Touristic Area (=1) | -0.563*** | |
| | (0.151) | |
| PPP Sanitation | 1.766*** | |
| | (0.072) | |
| Touristic Area · PPP Sanitation | 1.276*** | |
| | (0.239) | |
| Independence | -0.779 | |
| | (0.554) | |
| Indepedence$^2$ | -0.0323 | |
| | (0.502) | |
| Constant | 0.201* | |
| | (0.117) | |
| Observations | 4,814 | 4,814 |
| Control Group | 1,808 | 1,808 |
| Treatment Group | 3,006 | 3,006 |
| Pseudo R-squared | 0.166 | - |

Note: In model (1), the dependent variable is the private management dummy. Model (1) is the first-stage Logit that computes the propensity score. In model (2), the dependent variable is the price for a standard bill of water for a given municipality. Model (2) is a Kernel density function that matches units of observation from model (1) to compute the difference of the treatment. Robust Standard Errors in Parentheses with *** p<0.01, ** p<0.05, * p<0.1 in (1). Standard Errors in (2). The propensity-score is computed for the full-2008 sample.

Table 1.11: Selection Bias Before and After the Matching

| Variables | Sample | Treated | Control | % biased | Bias reduction | t-test | p≻\|t\| |
|---|---|---|---|---|---|---|---|
| **Urban** | Unmatched | 0.18097 | 0.0885 | 27.3 | | 8.86 | 0.000 |
| | Matched | 0.18097 | 0.16113 | 5.9 | 78.5 | 2.04 | 0.041 |
| **Touristic Area** | Unmatched | 0.1314 | 0.12279 | 2.6 | | 0.87 | 0.387 |
| | Matched | 0.1314 | 0.13015 | 0.4 | 85.4 | 0.14 | 0.885 |
| **PPP Sanitation** | Unmatched | 0.10679 | 0.01991 | 36.2 | | 11.28 | 0.000 |
| | Matched | 0.10679 | 0.1041 | 1.1 | 96.9 | 0.34 | 0.735 |
| **Touristic Area·PPP Sanitation** | Unmatched | 0.68297 | 0.2594 | 93.7 | | 31.25 | 0.000 |
| | Matched | 0.68297 | 0.68027 | 0.6 | 99.4 | 0.22 | 0.822 |
| **Independence** | Unmatched | 0.79706 | 0.86802 | -22.7 | | -7.43 | 0.000 |
| | Matched | 0.79706 | 0.79786 | -0.3 | 98.9 | -0.09 | 0.930 |
| **Independence$^2$** | Unmatched | 0.75393 | 0.82998 | -22.3 | | -7.33 | 0.000 |
| | Matched | 0.75393 | 0.7626 | -2.5 | 88.6 | -0.90 | 0.367 |

Note: The table shows mean comparison for the treated and control group before and after the matching process. The percentage of biased comparisons and bias reduction before and after the treatment are also reported. T-tests for equality of means in the treated and non-treated groups, both before and after matching, are reported in the last column. For good balancing, these should be non significant after matching. This is here the case except for the urban status.

Table 1.12: Bias Comparison Before and After Matching

| Sample | Pseudo-$R^2$ | LR Chi-2 | p≻Chi-2 | Mean Bias | Median Bias |
|---|---|---|---|---|---|
| Raw | 0.166 | 1059.04 | 0.000 | 34.1 | 25.0 |
| Matched | 0.003 | 24.61 | 0.000 | 1.8 | 0.9 |

Note: The table reports indicators for the raw and matched samples. After the matching the pseudo-$R^2$ is close to 0 which means that the only explanatory variable of the difference in price is the treatment. The mean bias is reduced from 34% to 1.8%.

Chapter 2

# "Make or Buy" in Water Markets*

## 2.1 Introduction

Since the landmark article of Coase [1937], a large body of the literature in industrial organization and strategy has tried to analyze the rationale behind the nature, organization and boundaries of the firm. Transaction cost economics - a leading theoretical perspective on this issue - describes how the governance structure of a given transaction is a function of the relative costs of transacting in markets and organizing procurement within the firm (see Williamson [1975] and Klein et al. [1978]). Typically, this question has been answered in either-or terms, favoring one governance mode over another depending on the transaction characteristics (see Bresnahan and Levin [2012] for an updated literature review).

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Yet, firms can and do simultaneously make and buy the same input[25], a phenomenon referred in the literature to variously as partial (Porter [1980]) or tapered integration (Azoulay [2004]), plural (Gulati et al. [2012]), dual (Adelman [1949]), or concurrent sourcing (Parmigiani [2007]) for example. The myriad of terms can have caused confusion to the study of the explanations of why firms make and buy the same input and how much they make and how much they buy. In this paper, we use the term "concurrent sourcing" to refer to the fact that firms may simultaneously rely on internal procurement as well as contracts for the rest of the market to produce its requirements. The paper does not focus on hybrid governance forms, that are mixed modes of procurement combining price and authority at the same time, which refer to procurement of the entire volume of the good from a single governance mode. Concurrent sourcing refers to the splitting up of the total volume being procured across multiple modes. Despite a rich literature on the make-and-buy decision in the last ten years and a better understanding of why firms both make and buy the same input, no article links the make-and-buy decision with a measure of performance.

In this paper, we attempt to fill the gap left in the previous literature by matching theories that can explain the organization and the boundary of the firm. We examine the economic organization of public services at two different tiers: the lease-manage decision at the city level (contracting for the public service) and the make-or-buy decision at the utility level (subcontracting for a part of water production). Our empirical analysis of the make-and-buy decision for water provision serves as an application of the economic organization and strategic management theory to a unique type of asset. Overall, a simple framework combining transaction costs and capabilities explains why firms buy rather than make. We not only test the relationship between leasing or concur-

[25] The typical example is the classical work by Monteverde and Teece [1982] in which the authors define "make" as when the firm produces 80 percent or more of its requirements and "buy" as when the firm produces less than this amount.

rent sourcing and features of the transaction - such as asset specificity, defined as the degree of idiosyncrasy of an investment required to produce a good, or complexity - but also on the capabilities of municipalities to monitor contracts and to produce water. We develop five testable implications: asset specificity has a negative impact on external procurement, transaction complexity - proxied by costly investments, has a positive impact on the level of external procurement, municipalities with higher contracting capabilities should more often rely on external procurement, municipalities with high production capabilities should select internal procurement, asset specificity moderates the impact of capabilities on external procurement while complexity strengthens the impact of capabilities on external procurement. We test these implications using a fine-grained dataset of roughly 4,000 water public services observed between 1998 and 2008. We find that municipalities experiencing high transaction costs respond to exogenous increases in demand by increasing internal production. On the contrary, municipalities that can draw on superior subcontracting capabilities decide to go on the market rather than produce internally to satisfy the increase in demand.

Our empirical approach builds on several articles that started a convergence between transaction costs economics (TCE) and the resource-based view (RBV) of the firm (Poppo and Zenger [1998], Leiblein and Miller [2003], Hoetker [2005], Mayer and Salomon [2006] and Fabrizio [2013] among others). Williamson [1999] himself recognized that TCE and RBV "deal with partly overlapping phenomena, often in complementary ways" and pointed out that a firm's history and capability matter to boundary choices. TCE focuses on the transaction as the unit of analysis and presumes that relative costs of internal versus external exchange determine the make-or-buy decision. The theory argues that choices are driven largely by the specificity of assets involved in an exchange. Despite huge empirical evidence (see Shelanski and Klein [1995] and Richman and Macher [2008] for a literature review), TCE alone cannot explain firm-level differences that influence governance decisions. Drawing heavily on Penrose [1959], the RBV (Wernerfelt [1984] and Teece [1982]) emphasizes differences in firm capabilities and frames the make-or-buy decision as a product of a firm's capabilities relative to competitors. More precisely, RBV sees governance decisions as reflecting what a firm can gain from market procurement (i.e. external capabilities) and its contracting capabilities (i.e. existing internal capabilities). It also distinguishes between incentives and the ability to outsource a transaction. Precisely, RBV argues that rents are derived from imperfectly imitable or imperfectly substitutable resources (Barney [1986]). Resources can be managerial, organizational or technological. Little is known however about how these relationships vary with the level of transaction costs (except Teece [1982] that argues that diversification and the existence of multi-product firm is best explained through joining RBV and TCE).

We believe that water supply is a good candidate for a study of the lease-manage decision and an analysis of concurrent sourcing. At its core, the make-or-buy decision in the water sector is no different from choosing whether to contract out the production of a good; such problem which has been widely studied in the markets for coal (Joskow [1985] and Joskow [1987]), trucking (Baker and Hubbard [2001] and Baker and Hubbard [2003]) but also public utilities (Crocker and Masten [1996]) for example. However, contrary to coal or trucks for example, water is not a fixed asset but instead, an asset whose size and quality are subject to substantial uncertainty depending on weather, hydrologic or seasonal conditions.[26] These characteristics are important to understand inter-city contracting on water trades to ensure continuity of service.

[26]Previous work on the make-or-buy in water has been studied in Chong et al. [2006] for France and Geddes and Troesken [2003] and Masten [2011] in the US for example. The three articles underline the efficacy of transaction costs to explain the lease-manage decision. However, the authors are only interested in explaining the organization of the public service by the local authorities and leave aside the make-or-buy decision at the utility level.

Finally, the French institutional context and the quality of our data makes such a study very interesting. In France, municipalities are responsible for the organization and provision of local public services, such as water, sanitation or waste management. Regardless of the organizational form, local authorities can trade raw or treated water with other local authorities. These trades are guaranteed through contracts between municipalities. Trades can occur for several reasons such as scarcity, rainfall and pollution for example. Water trades between municipalities are frequent because networks are largely interconnected. When demand increases, utilities can thus increase internal production or use external procurement to provide water. The French framework therefore makes possible the study of the reasons why utilities concurrently source the product. Another reason why we focus on water is that raw water quality can differ coming as it is from various sources, and it is applied different treatments that can alter costs. Such characteristics can drive organizational choices.

This study is linked to a rich emerging literature. The make-and-buy phenomenon is first underlined in Adelman [1949] who argue that firms concurrently source in times of demand uncertainty, pushing the fluctuations in volume onto suppliers in order to ensure full internal capacity and stable production. Porter [1980] adds to this view that firms will also concurrently source to gain an increased understanding of the production process and thus better monitor suppliers. In accordance with Williamson [1985], some papers observe that firms are not necessarily simultaneously making and buying the same thing[27]: Azoulay [2004] finds different patterns in outsourcing in drug development, data-intensive projects being outsourced while knowledge-intensive projects are internally procured[28]; He and Nickerson [2006] find that trucking

[27]Williamson [1985] writes that "where firms are observed to both make and buy an identical good or service, the internal technology will be characterized by higher asset specificity than will be external technology, ceteris paribus".

[28]In innovation-intensive industries, an early empirical contribution is made Veugelers and Cassiman [1999] who find that innovative firms are likely to combine internal and external

companies use their own drivers for orders that originate and terminate at company stores while they use external drivers for other orders. Nevertheless, other papers focus on firms that make and buy exactly the same input. Parmigiani [2007] finds that concurrent sourcing makes up for a governance choice in itself, different from the market and the hierarchy. Parmigiani and Mitchell [2009] find that concurrent sourcing is chosen when firms have sufficient expertise while they rather make in order to know. Theoretical perspectives are described in Gulati et al. [2012] and Krzeminska et al. [2012]. Gulati et al. [2012] put forward complementarity and constraints to explain the degree of make-and-buy. Their analysis suggests that constraints - such as limits to scale and barriers to exit - push firms away from corner solutions, while incentive and knowledge complementaries pull towards equal usage of the two procurement modes. Krzeminska et al. [2012] insist on TCE and capabilities as the main theories to explain concurrent sourcing.

This paper contributes to the literature on the boundary of the firm in several ways. First, our study sheds additional light onto the make-or-buy decision. Even if a standard theoretical approach combining TCE and RBV is used, our study suggests that an important source of differential capabilities impacting the decision to use the market rather than internal production comes from previous contracting experience in the same domain. Second, previous studies rarely assess how interactions between characteristics can mitigate or increase the level of concurrent sourcing. It is important to note that even if TCE and RBV are not competing theories of the firm, interactions between their characteristics can show some complementarities between the two. We particularly find that capabilities can mitigate transaction hazards. Third, we analyze the impact of the level of make-and-buy on utility performance, something that has never been documented in other articles on concurrent sourcing[29]. We particularly found that concurrent sourcing has a significant positive

knowledge acquisition.

[29]For an empirical analysis of the impact of the lease-management decision on perfor-

impact on quality performance but results in price premiums, potentially because external procurement demands capabilities to negotiate contracts and to mitigate ex post hazards. This study also raises several questions on allocation water markets, water conservation and instream uses.

The remainder of the paper is as follows. Section 2.2 gives an overview of water supply organization and regulation in France. Section 2.3 presents the theoretical background and the hypotheses of the paper. Section 2.4 describes the empirical identification and presents the results. Section 2.5 presents the results. Section 2.6 discusses the results and their limitations. A brief conclusion follows.

## 2.2 Make or Buy for Water Supply in France

### Contracting for the Organization of the Public Service

In France, as in most European countries, municipalities must provide local public services that have public good characteristics. Water provision and sewage are two of these public services and can be managed by two different operators. Water provision refers to the production and the distribution of water and sewage implies wastewater collection and treatment. In this paper we focus on water provision. Municipalities monitor prices, control entry and exit of firms into the market, organize competition and ensure uninterrupted service. However, if the responsibility for public services' provision is public, its management can be either public or private. Although some municipalities manage production through direct public management and undertake all operations and investments needed for the provision of the service, the dominating organizational form is private management. Under private management, the

mance, see Porcher [2012a].

main contractual form is delegated management.

According to the Cour des Comptes [2011], the highest financial court in France, 71% of the population is covered by a private operator for water provision and 56% for water sewage. In this case, a private operator, independent of the local government, is hired to manage the service and operate facilities, through one of the four different private-public arrangements. The most common is the *lease* contract in which the operator manages the service, invests in the network and gets a financial compensation through consumer receipts. Under a *concession contract*, the external operator also undertakes construction risk, as it must finance a large part of investments over the duration of the contract. These contractual agreements differ from the previous ones in that operators share risk in exchange for greater decision rights and claims on revenues. Other contracts can be chosen by the local authority such as the *gerance* in which it pays an external operator a fixed fee, or an *intermediary management contract*, i.e. a gerance contract but with a small part of the operator's revenues depending on its performance. Such contracts provide few incentives to reduce costs and transfer no risks and decision rights to a private operator. Although there are a large variety of contracts, the participation of the private sector is characterized by a concentration on three major companies. These companies share more than 90% of the private market with their subsidies, while other private companies operate mainly in small cities. All these contractual agreements are administrative contracts. The main criterion to characterize these contracts is that the selected operator organizes the public service of water.

Contrary to other industrialized countries, there is no price-cap or rate-of-return regulation for water utilities in France as there is no national regulator. Such regulation has been replaced by a contract, in the case of a private operator, or a decision of the municipality board, in the case of public operation. In the case of delegated management, rules have been defined to ensure that standards are respected during the operation to limit the opportunistic behavior of operators and guarantee competition between firms during the bidding process. First, since the "Sapin Law" (1993) a national legislative framework governs the form of the private sector participation and the conduct of the bidding process. The institutional framework to select the private partner is the following. If the public authority chooses a lease or a concession contract, it selects its partners in two steps. First, the public authority launches a classical invitation to tender that is open to all interested private water companies. Second, there is a negotiation phase between the public authority and potential entrants that are consequently shortlisted. At the end of the negotiation phase, the public authority chooses its final partner for the duration of the contract. The selection of the private company follows the *intuitu personae* principle according to which the municipality or the community sets a list of criteria to select the firm that is considered as the best partner.

Second, a strong regulation on contract duration and operators' obligations has been implemented in 1995 with the "Barnier Law". As a matter of fact, water quality in France has increased and is now relevant for more than 99% of the tests and a lot of investments have been provided to deter leaks. However, because regulation is made through contracts between the two parties, depending on the respective power of negotiators, with some contracts signed a century ago, there are doubts about the possibility of the parties to regularly adapt the tariffs to the needs of the utilities.

Furthermore, rules have been defined to ensure that standards are respected during the operation to limit the potential opportunistic behavior of operators. These rules support water quality, duration of contracts and information about management and provision quality. In the case of water quality, a precise definition of more than 60 verifiable quality parameters has been set by the 1992 water act to ensure that water services, would they be private or public, respect quality standards. Consequently, water quality is respected and is rarely below a 95% score of conformity to the standards of the microbiological analysis. Moreover, limits on duration have been set and management and provision information is now required to be publicly reported. To ensure that competition between operators arises, the “Barnier Law”(1995) gives a clear limitation to the duration of contracts and provides for an automatic renegotiation of the contract every five years. To struggle against information asymmetries, the executive power passed a decree in 2007 that forces municipalities and communities to provide 14 performance indicators in the mayor’s *Annual Report on Prices and Service Quality* (RPQS in French). These performance indicators and other data about water and sewerage services are collected from 2009 on by the *French National Observatory of Water and Aquatic Environments* (ONEMA in French) to provide data to inform users and citizens on their water services.

### Trading Water as Subcontracting

Unlike contracts presented above, contracts for buying and selling water, we call it *subcontracts*, are usually private-law contracts. These contracts are signed between two administrative authorities, a city or a group of cities.[30] However, under an outsourced public water service, subcontracts to trade water are usually integrated in the lease contract. The delegatee will ensure water production and distribution for the municipality but also its subcontracts signed with other municipalities.

[30] In some rare cases, the contracts are considered by the administrative court as being administrative contract. The criterion is that water trades have a direct impact on the organization of the public service of water. Water trades can have a direct impact on the organization of the public service when connecting investments must be undertaken to deliver water to the buyer.

There are at least six cases in which municipalities contract for trading water. The first case is obviously when water production is more expensive than buying it from neighbor cities. The second one is due to water scarcity. When water is scarce, it is common practice to trade to provide water to inhabitants. The third one is when raw water is of poor quality. In this case, the municipality can import raw water or treated water from another municipality. The fourth one is when a small municipality is located near a large water producer. In this case, it may prefer to buy rather than make to benefit from the scale of the economies of the nearby service. Fifth, municipalities can buy from neighbor municipalities that have contracted out with the same operator. It is rather common that private operators spot markets from the same neighbor in order to produce and trade more water, especially when networks are already interconnected[31]. Finally, large industrial factories can have a proper pipe connecting them to the water production plant. This is often the case for industries that need large volumes of raw water to function.

Trades in the water market are interesting to study for several reasons. First, despite differences in raw water quality, concurrent sourcing in the public water service is made on an equivalent good. Even if water is not produced exactly with the same technology (treatments and plant quality can differ), distributed water is a good that is homogeneous in quality and in its inherent characteristics. Second, trade frequency is important. Every year, 4 billion cubic meters of water are billed in France. Even if there are no clear statistics on global water imports and exports in France, the size and the level of the interconnections of the market increases the probability of concurrent sourcing. In our dataset, more than 85% of the cities are interconnected and 56% of municipalities that are interconnected both make and buy water. Third,

[31]The Competition Authority issued a judgment in 2005 about the lack of competition on water trades when different firms are operating in the same area.

various structural characteristics such as production capabilities make buying and selling capabilities rather exogenous to TCE and RBV. For these reasons, a significant impact of TCE and RBV on concurrent sourcing is particularly robust.

As our dataset provides no access to the subcontracts to exchange water, we collected annual reports on 139 bigger water utilities for 2009 that both produce and import water. All the utilities include at least one city with 15,000 inhabitants. We could get information on the subcontracts with other cities for a subsample of 62 public services. Descriptive statistics are reported in Table 2.1. From this subsample, we find no evidence that trades are organized between cities managed by the same operators. In most cases, the motivation reported to trade with other cities comes from the need for service continuity and the existence of contracts to trade water with cities around. These exchanges can be negotiated through long-term contracts but usually the trade is organized using a short-term contract of one year that is renewed every year with an adaptation of the volume sold.

Table 2.1: Contracts to Trade Water

| Variable | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| Billed Units | 5102.25 | 6671.26 | 681.358 | 40298 |
| Imports | 1302.13 | 2003.60 | 0.48 | 9835 |
| Average Number of Partners | 1.94 | 1.41 | 1 | 7 |
| Contracting with the Same Operator | 0.23 | 0.42 | 0 | 1 |
| Utilities Making-Buying and Selling | 0.26 | 0.44 | 0 | 1 |

Note: Billed Units and Imports in thousands cubic meter for 2009. The average number of partners is the average number of contracts for cities making and buying. The two last lines report the share of cities contracting with at least one city managed by the same operator and the number of cities that make, buy and sell water.

## 2.3 Theory and Hypotheses

### Transaction Costs and Outsourcing

TCE has been established as a dominant lens to view firm boundary decisions. In this theory, the firm considers the ex ante and ex post costs as the primary determiner of whether to conduct an activity internally or externally, as these are distinct governance structures. Because of opportunism and bounded rationality, the key question with respect to the make-or-buy decision is ascertaining when the transaction costs of using the market are larger than those of internal organization. For any transaction, a city purchases from external suppliers (or delegates the organization of the public service) when the cost of water in the market (the cost of monitoring the delegatee), added to the transaction costs, is less than the cost of internal production (direct management). Research on the public water service in the TCE literature has focused primarily on the transaction costs rationale for vertical integration (see Chong et al. [2006] and Chong et al. [2012]). They conclude that i) complexity is negatively associated with direct management and ii) that contracting out in public services with high asset specificity results in high transaction costs that positively impact prices. In the parlance of TCE, transaction costs associated with managing water supply are elevated because contract terms must account for transaction hazards such as expropriation or service discontinuity (see Brown and Potoski [2003] for an assessment of transaction costs in different public services) and because there is a chance of substantial risk of incurring costs through maladaptation, i.e. the failure to adapt. TCE stresses that production costs are not sufficient to understand integration reasons. However, scale economies for example can be influential in the decision to make rather than buy. Because of the need for system reliability, location-specific and time-specific uncertainty, there is always a demand for frequent *ex post* adaptation.

Asset specificity means that asset's value is reduced substantially if a complementary asset which is contracted for is unable to be secured. The general result from the literature is that vertical integration is likely to dominate temporary contracting when either of two agents in a relationship makes relationship-specific investments (Klein et al. [1978] and Williamson [1979]). If a buyer makes investments in assets which are specific to a relationship with a particular seller, then there is scope for opportunistic behavior in short-term contracts. The party not bearing the investment costs wields substantial bargaining power as the investing party stands to lose more if repeated negotiations fail. Vertical integration is the mechanism to avoid opportunistic behavior as a result of specific investments. Direct management is thus expected when a transaction involves investments in specific assets. Empirical results tend to confirm the link between asset specificity on the one hand and long-term contracting or vertical integration on the other (see Richman and Macher [2008] for a summary of the results). In water supply, geographic localizations are asset specific investments: water supply involves site specificity, physical asset specificity, dedicated assets and human asset specificity. We expect asset specificity to have a negative impact on the decision to contract out the public water service.

Asset specificity should also affect the choice to concurrently source for service continuity reasons but also because of dependency. Importing water needs contracts that can mitigate opportunism. When transaction costs are high, municipalities will increase the percentage of their own production to the point of full integration. We expect asset specificity to have a negative impact on the level of concurrent sourcing.

**Hypothesis 1.** *Asset Specificity has a negative impact on contracting out for the organization of the public service. It has a negative impact on concurrent sourcing too.*

A common assumption in public procurement (see Levin and Tadelis [2010]) is that complexity in providing the service is assumed to be linked with contracts harder to write, monitor or adjust. Indeed, contracts that must agree on detailed plans of action to safeguard hold-up problems are more "relational" in a hierarchy. Under hierarchy, ex ante agreements leave small room for decision rights and render adaptations more flexible. This argument must however be mitigated by the sensitivity of city administrators to the ultimate quality provided. Regulators or monitors that are aware of complexity can decide to lease the public service because its uncertainty makes it more complex. These trade-offs play out differently across cities. For example, cities with high-level of (sub)contracting capabilities can be keener on leasing complex services and buying rather than making when water is complex to produce. Overall, we argue that everything else being equal, complexity has a positive impact on the outsourcing decision. Similarly, we expect complexity to have a positive impact on concurrent sourcing.

**Hypothesis 2.** *Complexity has a positive impact on contracting out for the organization of the public service and on concurrent sourcing.*

### Capabilities as an Input to Outsourcing

As propounded above, there are two main assumptions in the transaction cost theory of contracting. First, the agents are unable to anticipate all possible future contingencies that affect the contractual relationship when they design and negotiate the contracts. Second, they can foresee major contractual hazards stemming from potential opportunism and then devise contractual structures to mitigate them.[32]

[32] Williamson [1996] himself explained that TCE "maintains that many economic agents have the capacities to learn and to look ahead, perceive hazards, and factor these back into the contractual relation, thereafter to devise responsive institutions. In effect, limited but intentional rationality is translated into incomplete but farsighted contracting."

Common wisdom among city administrators is that familiarity and experience with writing and administering contracts lowers the costs of using contracts for any given service. Municipalities with higher contractual experience with the private sector contracting on other services are more likely to outsource their public water service. We believe also that subcontracting matters when it comes to explain these choices. Cities importing and exporting significant volumes of water should have more contractual capabilities. We thus expect a positive relationship between subcontracted trades among public water services and outsourcing the water public service.

Another factor influencing the level of conflict among contractors is the relation between each transaction and other exchanges, depending on the actual type of transaction (Coase [1937]). The more homogeneous transactions are, the less expensive internal control of similar transactions and the higher the probability of contracting out are. We expect to find a positive relationship between similarity in transactions and contracting out for the water public provision. For example, municipalities leasing their sanitation public service should also lease their water public service. Similarly, municipalities that sell water to other municipalities should more frequently buy rather than make water.

Another theoretical contribution by Milgrom and Roberts [1990] use complementarities to refer to a situation in which the performance consequences of a choice depend on other choices. For example, the marginal returns to one activity increase as a firm does more of the other activities. Complementarities can be widespread or focal. In the context of the public service organization and water horizontal trades, complementarity simply refers to the condition in which the marginal benefit of procuring a good from the market depends on the level of in-house production, and vice versa[33]. One of the factors that levels out in-house production regarding external procurement is (sub)contracting capabilities. More specifically, utility or city experience in doing one thing can have a positive impact on the tendency to take complementary contracts.

**Hypothesis 3.** *(Sub)Contracting capabilities have a positive impact on contracting out the public service and on concurrent sourcing.*

Finally, regardless of conflicts among transactors, there are short-term problems affecting contracting decisions, such as a constraints of production capabilities. Utilities with high production capabilities can be characterized by two trade-offs. The first one is that their production capabilities risks the hold-up problem. In this case, we would expect production capabilities to have a negative impact on contracting-out the water public service and concurrent sourcing. Moreover, there are also costs of bureaucracy with increasing scale of production that can influence the choice to have recourse to the market. In this case, the impact of production capabilities can be positive. The second characteristic is that municipalities with shortages in their production capabilities are naturally constrained in their production choices. In the case of water trades, municipalities have more incentives to increase concurrent sourcing. In some cases however, there are barriers to exit production. In natural monopoly such as water, fixed costs take on the form of sunk investments, which make average price decrease. This can be interpreted as incentives to produce and it has a negative impact on concurrent sourcing. We thus expect production capabilities to have a negative impact on outsourcing and concurrent sourcing.

[33] In the competitive market, complementarity is divided between incentive complementarity (Porter [1980]) and knowledge complementarity (Dyer and Singh [1998] for example). The former is based on competition between internal production and outsourced production. The idea is that concurrent sourcing gives the firm the ability to credibly threaten backward integration to their suppliers. The latter is based on collaboration between internal and external suppliers in order to create value for the procuring firm. As a result, firms benefit internal and external suppliers' knowledge improvements in production processes and technologies.

**Hypothesis 4.** *Production capabilities have a negative impact on outsourcing and on concurrent sourcing.*

Another proxy for production capabilities is the pricing of the input. Indeed, a simple reason motivating water trades is differences in retail prices between municipalities or group of municipalities that are located in the same area. Concurrent sourcing also depends on the level of capabilities that the firm possesses, relative to those possessed by potential suppliers (Demsetz [1988] and Jacobides and Winter [2005]). As Barney [1991] and Jacobides and Winter [2005] noticed, in a market, firms differ in their cost-efficiency or product quality. Behind the façade of "the market" lies another firm that produces a product. In this sense, the market is only an intermediary for buying and selling products and services. Firms that decide to use contracts to buy and sell water compare their abilities with those of other firms. Subcontracting occurs when there are gains for trade; it is an economizing solution. Utilities differ in their productive capabilities regardless of scale, and will buy from other suppliers if the latter can carry out the same activity at lower cost. Differences in production costs among utilities are incentives to trade water for economizing reasons. We will particularly focus on this point when we study concurrent sourcing.

### Interactions

In cases where transactions are complex and hazards common, a more capable firm will establish routines that facilitate ex post adaptation and improve the likelihood of mutually agreeable outcomes. Lack of control over the production process or the buying mechanism can increase or mitigate transaction costs such as asset specificity or complexity. For example, under high asset specificity, we would expect contractual capabilities to have a smaller impact than under low asset specificity. On the contrary, production capabilities are less valuable when complexity is high. We expect asset specificity to mitigate the impact of capabilities to outsource and increase the impact of capabilities to produce.

**Hypothesis 5.** *The influence of contracting (production) capabilities on the lease-manage decision and concurrent sourcing will be less (more) pronounced when asset specificity is important.*

## 2.4 Data and Empirical Identification

### Datasets and Measures

The unique and fine-grained dataset we use in this study merges three sources. The data comes from the French Environment Institute (IFEN-SOeS), the French Health Ministry (DGS) and the French National Institute for Economics and Statistics (INSEE). The unit of observation is a municipality. We observe a set of 5,000 cities in France during four years: 1998, 2001, 2004 and 2008. These cities are withdrawn from a representative set of municipalities. The final dataset is made of 12,291 observations, grouping 3,921 municipalities. Mean covariates and standard deviation are presented in Table 2.2 for the whole sample.

The IFEN-SOeS, collected by the French Environment Institute and the Environment Minister, is a nationally-representative municipal survey of the public service of water. This sample is representative of the total French population and the local public authorities from where they are living: all sizes of local authorities are proportionally represented and municipalities with more than 5,000 inhabitants are all represented. The IFEN-SOeS database provides detailed information about water public services and municipalities' characteristics. There have been four data collections in the last ten years. The data collection proceeds as follows. Municipalities fill in the database, then the data is checked by the Environment Minister. The IFEN-SOeS is the only representative national dataset on water public services. The database includes a lot of information about water supply at the municipal level - e.g. billed water in thousands, water sources, treatments and municipalities' characteristics that can influence water consumption. It includes also some data coming from the census made by INSEE. This provides information concerning incomes, regions and information about structural characteristics of the municipalities for example.

Regarding the TCE, we have several variables that account for asset specificity and complexity. Asset specificity is measured by the pipes' length in kilometers. The former accounts for asset specificity as investments on the network cannot be used for other purposes. We then use several proxies for complexity. Usually, this complexity is inherent to each municipality. For example, municipalities that are based in a touristic area need more skills to manage their water infrastructures. Touristic areas face larger levels of consumption and need to increase their production capabilities during some periods of the year. Moreover, pipes are often overextended to satisfy touristic consumption during summer. We borrowed from INSEE a dummy that takes 1 when the municipality is located in a touristic area and 0 otherwise. Other measures of complexity are more traditional. For example, ground water is usually associated with higher treatment complexity because it is more polluted than underground water. For instance, ground water is associated with higher production costs than underground water. Some municipalities use multiple sources or raw water. From the IFEN-SOES dataset, we know whether raw water comes from ground, underground or mixed sources. We used dummies that equal 1 when raw water comes from ground or mixed sources and 0 otherwise.

Water treatment does not only approximate the complexity of service provision but also the level of specific investments needed to operate the service. A telltale story is that ground water is associated with more complex treatments than underground water. Under mixed sources of water, costs might be higher than for ground or underfoot sources as the utility might need a treatment factory for each type of water. Treatments are six fold and coded between 1 and 6 in the IFEN-SOeS dataset. From this treatment variable we built two variables that account for complexity. We built three dummies that account for treatment complexity and mixed treatments. *Complex Treatment* is equal to 1 if water needs a heavy disinfection treatment plus extra-controls. We also built a dummy *Mixed Treatment* that equals 1 if water needs mixed treatment. We finally built a dummy equal to 1 if the treatment is mixed and complex.

We built several variables that account for the RBV. We built the variable *Concurrent Sourcing* that is measured as the ratio between water imports and water imports plus water production of a given city $i$ at year $t$. *Selling Capabilities* are measured as the ratio between water exports and exports plus billed water for a given $i$ in $t$. We also built a variable *Subcontracting Capabilities* that relates buying and selling capabilities. It is measured as the ratio between the sum of imports and exports and billed water. We also used a dummy equal to 1 if the city leases the sanitation public service. We expect these variables to have a positive impact on outsourcing.

We also took into account some other variables that measure municipalities' capabilities. Technical capabilities are assessed by the *Production Capabilities* that are measured as the ratio between water produced and billed water for a city $i$ in $t$. We also include a proxy for competitive capabilities that is the relative price between the marginal price of city $i$ and the average regional marginal price of exports. The intuition is that relative prices can motivate exchange, especially imports when the local price of water is high. This variable is especially important to explain the make-and-buy decision at the utility level.

Several controls are included in the model. We included some characteristics such as whether water provision is made by a group of cities or by a single city. Population and incomes are important controls, because they can impact the city's resources. Including such controls purges effects that can be linked to the size or the economic conditions of the city. We also considered fixed effects in all models such as regional and time fixed effects. This accounts for norms, rules and market structure that can influence contract hazards associated with TCE. These controls are also important because there can be some unobservable characteristics that can impact the outsourcing decision such as competition or the political agenda.

### Descriptive Statistics

Table 2.2 defines the variables used in this study and descriptive statistics for the whole sample. The unit of observation is a municipality. The table is divided in three panels. Panel (A) shows the TCE variables, Panel (B) presents the RBV variables, Panel (C) describes other controls and Panel (D) shows production and demand variables. The table is divided between in-house and outsourced public services.

We now briefly discuss what we observe in the descriptive statistics. Taking a glance at the TCE characteristics in Panel (A), we can see that asset specificity measured by the length of pipes is almost not different between in-house and outsourced services. However, complexity, measured by being

Table 2.2: Descriptive Statistics

| **Variable** | **Definition** | **In-house** | **St. Dev.** | **Outsourced** | **St. Dev.** |
|---|---|---|---|---|---|
| **Panel A: Transaction Costs Economics Variables** | | | | | |
| Asset Specificity | Pipes Length in kilometers, logged | 3.346 | (1.165) | 3.710 | (1.042) |
| Touristic Area | Dummy equal to 1 if city is touristic | 0.125 | (0.331) | 0.136 | (0.342) |
| Ground Water | Dummy equal to 1 if water comes from a ground source | 0.080 | (0.271) | 0.147 | (0.354) |
| Mixed Water | Dummy equal to 1 if water comes from ground and underground sources | 0.137 | (0.344) | 0.223 | (0.416) |
| Complex Treatment | Dummy equal to 1 if treatment is heavy | 0.089 | (0.284) | 0.222 | (0.416) |
| Mixed Treatment | Dummy equal to 1 if treatment is mixed | 0.072 | (0.258) | 0.056 | (0.231) |
| Mixed-Complex Treatment | Dummy equal to 1 if treatment is mixed and complex | 0.029 | (0.168) | 0.059 | (0.236) |
| **Panel B: Resource Based View Variables** | | | | | |
| Concurrent Sourcing | Ratio of Imports and Production plus Imports | 0.068 | (0.168) | 0.119 | (0.240) |
| Selling Capabilities | Ratio of Exports and Billed Units plus Exports | 0.054 | (0.112) | 0.072 | (0.127) |
| Subcontracting capabilities | Ratio of Imports plus Exports and Billed Units | 0.203 | (0.449) | 0.323 | (0.956) |
| Contract in Sanitation | Dummy equal to 1 if the public sanitation service is contracted out | 0.263 | (0.440) | 0.701 | (0.458) |
| Production Capabilities | Ratio of water Production on Billed Units | 1.469 | (0.913) | 1.317 | (0.879) |
| Relative Price | Ratio of city $i$ marginal price and the average exporters' regional marginal price | 0.970 | (0.314) | 1.081 | (0.314) |
| **Panel C: Other controls** | | | | | |
| Group of Cities | Dummy equal to 1 if the city is part of a group of cities | 0.624 | (0.484) | 0.737 | (0.440) |
| Semi-Urban Area | Dummy equal to 1 if the city is located in a semi-urban area | 0.410 | (0.492) | 0.382 | (0.486) |
| Urban Area | Dummy equal to 1 if the city is located in an urban area | 0.136 | (0.343) | 0.227 | (0.419) |
| Ln(pop) | City population, logged | 7.438 | (1.537) | 8.082 | (1.544) |
| Relative Income | Ratio of the median income of city $i$ and the lowest median income in $t$ | 2.929 | (1.027) | 3.069 | (1.207) |

Note: Panel (A) describes variables used as proxies for the TCE. Panel (B) presents data corresponding to the RBV. Panel (C) gives descriptive statistics for the other controls.

Table 2.3: Descriptive Statistics

| Variable | Definition | Make | St. Dev. | Make and buy | St. Dev. |
|---|---|---|---|---|---|
| **Panel A: Transaction Costs Economics Variables** | | | | | |
| Asset Specificity | Pipes Length in kilometers, logged | 3.407 | (1.129) | 3.790 | (1.027) |
| Touristic Area | Dummy equal to 1 if city is touristic | 0.126 | (0.332) | 0.140 | (0.347) |
| Ground Water | Dummy equal to 1 if water comes from a ground source | 0.093 | (0.290) | 0.160 | (0.366) |
| Mixed Water | Dummy equal to 1 if water comes from ground and underground sources | 0.131 | (0.338) | 0.267 | (0.443) |
| Complex Treatment | Dummy equal to 1 if treatment is heavy | 0.112 | (0.315) | 0.251 | (0.433) |
| Mixed Treatment | Dummy equal to 1 if treatment is mixed | 0.050 | (0.218) | 0.076 | (0.265) |
| Mixed-Complex Treatment | Dummy equal to 1 if treatment is mixed and complex | 0.027 | (0.163) | 0.074 | (0.263) |
| **Panel B: Resource Based View Variables** | | | | | |
| Selling Capabilities | Ratio of Exports and Billed Units plus Exports | 0.056 | (0.117) | 0.077 | (0.129) |
| Subcontracting capabilities | Ratio of Imports plus Exports and Billed Units | 0.090 | (0.295) | 0.511 | (1.125) |
| Contract in Sanitation | Dummy equal to 1 if the public sanitation service is contracted out | 0.552 | (0.497) | 0.534 | (0.499) |
| Production Capabilities | Ratio of water Production on Billed Units | 1.518 | (0.999) | 1.192 | (0.709) |
| Relative Price | Ratio of city $i$ marginal price and the average exporters' regional marginal price | 1.020 | (0.337) | 1.067 | (0.292) |
| **Panel C: Other controls** | | | | | |
| Group of Cities | Dummy equal to 1 if the city is part of a group of cities | 0.617 | (0.486) | 0.777 | (0.416) |
| Semi-Urban Area | Dummy equal to 1 if the city is located in a semi-urban area | 0.411 | (0.492) | 0.368 | (0.482) |
| Urban Area | Dummy equal to 1 if the city is located in an urban area | 0.184 | (0.388) | 0.207 | (0.405) |
| Limitation | Dummy equal to 1 if water consumption is limited in the city | 0.057 | (0.232) | 0.057 | (0.232) |
| Ln(pop) | City population, logged | 7.638 | (1.592) | 8.114 | (1.507) |
| Relative Income | Ratio of the median income of city $i$ and the lowest median income in $t$ | 2.982 | (1.090) | 3.065 | (1.214) |
| Private Management | Dummy equal to 1 if the water service is managed by a private firm | 0.601 | (0.490) | 0.699 | (0.459) |
| **Panel D: Production and Demand** | | | | | |
| Production | Water units generated by the city | 737.500 | (2882.208) | 889.674 | (6148.334) |
| Demand | Billed units in city $i$ in year $t$ | 519.782 | (2337.808) | 766.717 | (5419.696) |

Note: Panel (A) describes variables used as proxies for the TCE. Panel (B) presents data corresponding to the RBV. Panel (C) gives descriptive statistics for the other controls. Panel (D) describes production and demand characteristics.

a touristic area, water types and treatment types, is largely higher in cities that outsourced their water public service. Complexity may be a driver for outsourcing the public service. Panel (B) shows that municipalities that outsourced the organization of the public service are characterized by higher levels of subcontracting and contracting capabilities. For example, concurrent sourcing is 5 points higher under outsourced public water service. Outsourced public services have small production capabilities. Other controls are described in Panel (C). We observe for example that leasing is positively correlated with whether the city is part of a group of cities, relative income and the size of the population.

Table 2.3 is similar to Table 2.2 but includes four panels regarding whether there is a make and buy decision. Like in Table 2.2, Panels (A), (B) and (C) respectively show the TCE, RBV variables and the other controls. Panel (D) shows production and demand variables. The table is divided between public services that only make and both make and buy. In Panel (A), asset specificity and complexity are higher for services that make and buy. While complexity is clearly a shifter from make to the make-and-buy decision, asset specificity would be expected to be higher in cities that only make. Yet, the reason can simply be that small utilities only make while large utilities both make and buy. Panel (B) shows that municipalities that outsourced the organization of the public service are characterized by higher levels of subcontracting but not necessarily higher level of contracting capabilities. For example, the ratio of exports on total billed units is 2 points higher (7.7% versus 5.6%) for services that make and buy. As expected, utilities that make and buy are characterized by smaller production capabilities.

Finally, Panels (C) shows that population and income are on average higher in utilities that both make and buy. We also observe that private management is more distributed in utilities that make and buy water. Our dataset does not allow neither to check neither for the identity of buying and selling utilities. An intuitive reason for the distribution of private management is that utility managed by private firms tend to exchange with neighbor utilities managed by the same operator. Finally, Panel (D) shows that production and billed units are higher in utilities that make and buy, thus confirming that utility's size is probably a driver of the make and buy decision. These characteristics are important to understand how production increases when demand increases.

### Empirical Identification

We first empirically assess the determinants of the lease-manage decision for service provision and we then test the propensity to concurrently source water at the utility-level. To asses the lease-manage decision, we first use an OLS and a Probit model in which the dependent variable is a dummy that equals 1 if the mode of provision is lease and 0 if the mode of provision is direct management. The standard model can be written as follows:

$$Contract_{it} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 Y_{it} + \alpha_3 X_{it} \cdot Y_{it} + \sigma_{it} \tag{2.1}$$

where $X_{it}$ is a set of variables capturing TCE characteristics and $Y_{it}$ a set of RBV variables. We particularly cross what we consider to be the most important TCE characteristics, asset specificity, with some proxies for capabilities. We expect asset specificity and production capabilities to have a negative impact on the probability to lease while complexity and contracting capabilities should have a positive impact. We then run a 2SLS regression, using the same specification but instrumenting subcontracting capabilities for a set of variables that are exogenous to the make-or-buy decision. We will discuss these instruments later on. Our model allows us to test for the five hypotheses presented above.

In a second step, we use two different models to compute the impact of TCE and RBV on concurrent sourcing. As all utilities are not interconnected, we apply a simple Heckman [1979] selection model. In the first stage, we use a Probit model of the probability of observing the data regarding a function of regressors independent from observed marginal costs. The selection equation is:

$$V_i = \beta_0 + \beta Z_i + \eta_i \tag{2.2}$$

where $V_i$ is a latent variable equal to one if the city is interconnected with other cities, $\beta$ the vector of coefficients for the selection equation, $Z_i$ the vector of covariates for city $i$ and $\eta_i$ the random disturbance for a given city $i$. The vector of covariates includes dummies for the urban, semi-urban or rural status, a dummy equal to 1 if the city is located in a touristic area, a dummy equal to 1 if water consumption is limited in the city and regional fixed-effects.

The first model uses an OLS regressor and takes concurrent sourcing as the dependent variable. In this case, we expect concurrent sourcing to be impact by proxies for TCE and RBV as in equation (2.1). High transaction costs and production capabilities should have a negative impact on concurrent sourcing while complexity contracting capabilities should have a positive impact. The equation takes the following form:

$$ConcurrentSourcing_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Y_{it} + \beta_3 \cdot X_{it} \cdot Y_{it} + \epsilon_{it} \tag{2.3}$$

with $ConcurrentSourcing_{it}$ the share of imports relative to the stock of water of the utility $i$ in year $t$, $X_{it}$ a set of variables capturing TCE and $Y_{it}$ a set of variables capturing RBV characteristics. This equation is rather similar to the lease-manage equation for the organization of the public service. The second equation exploits exogenous changes in customer demand to estimate the impact of TCE and capabilities on in-house production. The model takes the following form:

$$Production_{it} = \beta_0 + Demand_{it}(\beta_j X_{it} + \beta_k Y_{it} + \beta_l X_{it} \cdot Y_{it}) + \beta_1 X_{it} + \beta_2 Y_{it} + \epsilon_{it} \tag{2.4}$$

with $Production_{it}$ the level of production of the utilities, $Demand_{it}$ the demand at the municipal level, $X_{it}$ a set of variables capturing TCE and $Y_{it}$ a set of controls RBV variables. In this case, we estimate concurrent sourcing in the following way. When demand increases, municipalities can respond by increasing production or increasing imports. When transaction costs are important, municipalities tend to increase production rather than imports ($\beta_j \geq 0$) as hypothesis 1 stands. On the contrary, when capabilities to contract out are important for example, municipalities respond to demand by increasing imports ($\beta_j \leq 0$) as hypothesis 3 suggests. We explore local producers' responses to increase in demand because water utilities serve anticipated demand with existing assets, which are difficult to modify in the short term. The crossed variables are of interest because they will give the sense of the response of producers to increased demand. We then include three-way interactions between $X_{it}$ and $Y_{it}$ to test hypothesis 5, i.e. whether asset specificity can mitigate or increase the impact of capabilities. We expect equation (2.1) and (2.3) on the one hand and (2.4) and (2.3) on the other hand to have similar implications. In this case, TCE and RBV would not only be consistent contracting theories to study the lease-own decisions such as franchising as much as make-and-buy decisions for the same good in the same industry. Precisely, the results of this equation would give broader implications to the research on why firms both make and buy.

We finally test the impact of the make-and-buy decision on various performance indicators such as price, water quality and network performance, controlling for all fixed effects such as regional, year, complexity fixed effects and including all controls. In these models, we expect utilities to face a trade-off between price and quality.

## 2.5 Results

### Lease-Manage Decision

Table 2.4 presents the results of our empirical strategy. For all models, the dependent variable is a dummy variable accounting for the lease-manage decision that takes 1 if the city leases the water public service and 0 either. Models (1) and (4) are OLS models, models (2) and (5) are probit regressions, and models (3) and (6) are 2SLS regression. Models (1), (2) and (3) are basic specifications. Models (4) to (6) include an interaction between asset specificity and whether the city has contracted out its sanitation public service.

We first comment on the baseline results of for all models. As expected, (sub)contracting capabilities, measured by *subcontracting capabilities*, *concurrent sourcing*, *selling capabilities* and whether the city has a *contract for sanitation* have all a significant positive impact in all models, except model (5) for the contract for sanitation dummy. Hypothesis 3 is thus validated. *Production capabilities* has a significant negative impact as hypothesis 2 states in all models. If we now have a look at hypotheses 1 and 2, we find that *asset specificity* has always a significant negative impact on leasing the public service. Complexity, measured by a set of dummies to take into account whether the municipality is *touristic*, the treatment is *mixed*, *complex* or both and water comes from a *ground* or a *mixed* source, has overall a positive significant impact on leasing. Yet, *Mixed* and *Mixed an Complex Treatment* do not have a significant impact while the dummy for the *touristic area* has a negative and significant negative impact on leasing in all models except model (2). Hypothesis 2 is thus partly validated.

We now specifically comment on models (4) to (6) that include the inter-

Table 2.4: The Lease-Manage Decision as a Function of Capabilities and Transaction Costs

| Variables | (1)<br>OLS<br>Lease | (2)<br>Probit<br>Lease | (3)<br>IV<br>Lease | (4)<br>OLS<br>Lease | (5)<br>Probit<br>Lease | (6)<br>IV<br>Lease |
|---|---|---|---|---|---|---|
| Subcontracting Capabilities | | | 0.0532*** | | | 0.0516*** |
| | | | (0.0096) | | | (0.0096) |
| Concurrent Sourcing | 0.0774*** | 0.357*** | | 0.0732*** | 0.321*** | |
| | (0.0158) | (0.0659) | | (0.0158) | (0.0665) | |
| Selling Capabilities | 0.150*** | 0.531*** | | 0.154*** | 0.564*** | |
| | (0.0286) | (0.112) | | (0.0284) | (0.113) | |
| Contract for Sanitation (=1) | 0.371*** | 1.237*** | 0.371*** | 0.134*** | 0.0169 | 0.132*** |
| | (0.00714) | (0.0256) | (0.00716) | (0.0243) | (0.0857) | (0.0244) |
| Production Capabilities | -0.0145*** | -0.0504*** | -0.0152*** | -0.0149*** | -0.0547*** | -0.0152*** |
| | (0.00506) | (0.0160) | (0.00450) | (0.00492) | (0.0159) | (0.0043) |
| Group of Cities (=1) | 0.140*** | 0.523*** | 0.140*** | 0.141*** | 0.533*** | 0.141*** |
| | (0.00771) | (0.0290) | (0.00769) | (0.00764) | (0.0294) | (0.0076) |
| Asset Specificity | -0.0166** | -0.0621** | -0.0160** | -0.0511*** | -0.211*** | -0.0507*** |
| | (0.00750) | (0.0282) | (0.00750) | (0.00848) | (0.0302) | (0.0085) |
| —·Contract for Sanitation | | | | 0.0658*** | 0.352*** | 0.0663*** |
| | | | | (0.00633) | (0.0245) | (0.0063) |
| Touristic Area (=1) | -0.0213** | -0.0622 | -0.0220** | -0.0250*** | -0.0830** | -0.0257*** |
| | (0.00934) | (0.0385) | (0.00935) | (0.00935) | (0.0410) | (0.0094) |
| Mixed Treatment (=1) | -0.0149 | -0.0454 | -0.0159 | -0.0117 | -0.0211 | -0.0128 |
| | (0.0142) | (0.0513) | (0.0142) | (0.0141) | (0.0533) | (0.0142) |
| Complex and Mixed Treatment (=1) | 0.00133 | 0.0179 | -0.00138 | 0.001 | 0.0413 | -0.0021 |
| | (0.0151) | (0.0679) | (0.0153) | (0.0151) | (0.0722) | (0.0152) |
| Complex Treatment (=1) | 0.0449*** | 0.188*** | 0.0446*** | 0.0448*** | 0.195*** | 0.0445*** |
| | (0.0106) | (0.0456) | (0.0107) | (0.0105) | (0.0463) | (0.0106) |
| Ground Water (=1) | 0.0258** | 0.122** | 0.0234** | 0.0282** | 0.140*** | 0.0260** |
| | (0.0118) | (0.0496) | (0.0118) | (0.0117) | (0.0506) | (0.0118) |
| Mixed Water (=1) | -0.0642*** | 0.261*** | 0.0648*** | 0.0660*** | 0.278*** | 0.0666*** |
| | (0.00971) | (0.0392) | (0.00975) | (0.00969) | (0.0401) | (0.0097) |
| Semi-Urban Area (=1) | -0.0321*** | -0.120*** | -0.0319*** | -0.0337*** | -0.117*** | -0.0334*** |
| | (0.0110) | (0.0407) | (0.0110) | (0.0109) | (0.0405) | (0.0109) |
| Urban Area (=1) | -0.0459*** | -0.169*** | -0.0449*** | -0.0423*** | -0.126** | -0.0412*** |
| | (0.0168) | (0.0621) | (0.0168) | (0.0167) | (0.0630) | (0.0167) |
| Ln(Pop) | 0.0654*** | 0.242*** | 0.0660*** | 0.0632*** | 0.225*** | 0.0637*** |
| | (0.00660) | (0.0246) | (0.00661) | (0.00657) | (0.0249) | (0.0066) |
| Income Ratio | 0.00268 | 0.00927 | 0.00335 | 0.00201 | 0.00284 | 0.00261 |
| | (0.00420) | (0.0170) | (0.00423) | (0.00417) | (0.0169) | (0.0042) |
| Constant | 0.0723* | -1.297*** | 0.0655* | 0.226*** | -0.561*** | 0.220*** |
| | (0.039) | (0.157) | (0.0397) | (0.0420) | (0.162) | (0.0422) |
| Regional FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,209 | 15,209 | 15,209 | 15,209 | 15,209 | 15,209 |
| R-squared (Pseudo in Probit) | 0.325 | 0.292 | 0.320 | 0.330 | 0.304 | 0.325 |
| First-Stage R-squared | | | 0.231 | | | 0.231 |

Note: Robust standard errors in parentheses with *p<0.10, **p<0.05, ***p<0.01. Models (1) and (4) are OLS models. Models (2) and (5) are Probit models. Models (3) and (6) are 2SLS models with two instruments, the relative price and the rank of ordered observations by subcontracting capabilities. The instrument has the property that it is correlated with subcontracting capabilities but uncorrelated with the dependent variable.

action term between *asset specificity* and whether the city has a *contract for sanitation*, i.e. a lease contract in a similar public service. As we can see, the interaction term between the two terms is significantly positive in all specifications. It means that having signed a contract for sanitation can override the negative impact of asset specificity on the leasing decision. This is particularly important because it reveals that experience in contracting can mitigate transactional hazards. In other words, municipalities with experience in designing and operating complex and incomplete contracts may be more accustomed to ex post adaptation. This result is consistent with hypothesis 5.

In model (3) and (6), we endogenize *subcontracting capabilities* using two instruments that we built. The first one is the rank of ordered observations by subcontracting capabilities intensity (see Greene [2011]). The instrument has the property that it is correlated with subcontracting capabilities but uncorrelated with the dependent variable. We also build a second instrument that is the ratio between the marginal price of the observed city and the marginal price of exports at the regional level. The smaller the ratio is, the lower the advantage of neighbor utilities is and the higher the impact of this variable on buying rather than making is. The impact of subcontracting capabilities is positive and significant when it is instrumented, thus confirming the previous results.

### Concurrent Sourcing

Table 2.5 reports the results of equation (2.3) with concurrent sourcing as a dependent variable. Models (1) and (2) are OLS regressions. In all models, concurrent sourcing depends on TCE and RBV characteristics but model (2) includes crossed variables to measure the impact of the degree of asset specificity on selling and producing capabilities. We first comment on the main impacts. In all models, contracting capabilities at the utility-level, measured by *selling capabilities*, have a significant positive impact on concurrent sourcing. Experience in subcontracting to sell water fosters buying from other municipalities as hypothesis 3 stands. The main impact of *production capabilities* is significantly negative in both models and strongly supports hypothesis 4. We included another proxy for production capabilities that is the relative marginal price of an unit of production. The lower the relative price is, the more competitive the production capability of the city is and the less it will concurrently source water. We thus expect a positive relationship between the relative price and the level of concurrent sourcing. As expected, the higher the *relative price* of city $i$ relative to the average regional marginal price is, the more the utility concurrently sources the good.

We now turn to the TCE variables. Asset specificity measured as network length has a positive impact in model (1) and a non-significant negative impact in model (2) on concurrent sourcing, which is contrary to hypothesis 1. One of the reasons why we find this positive link between asset specificity and concurrent sourcing is linked to our measure of asset specificity. Indeed, the length of the network is positively related to the interconnection of cities that facilitates concurrent sourcing. Yet, the specificity of the investments on pipes should deter contracting with other municipalities. In model (2), we find this negative relationship between asset specificity and concurrent sourcing but the coefficient is not significant. We however expect asset specificity to mitigate capabilities. Hypothesis 2 is partly supported as our proxies for complexity overall have a significant positive impact on concurrent sourcing, except *ground water* that has a significant negative impact. When domestic production of water is difficult, utilities choose to make and buy, rather than buy, but this is not always the case.

Table 2.5: Concurrent Sourcing as a Function of Capabilities and Transaction Costs

| Variables | (1)<br>OLS<br>Concurrent Sourcing | (2)<br>OLS<br>Concurrent Sourcing |
|---|---|---|
| Selling Capabilities | 0.171*** | 0.524*** |
| | (0.045) | (0.117) |
| Production Capabilities | -10.65*** | -23.12*** |
| | (2.294) | (5.514) |
| Asset Specificity | 1.677*** | -1.812 |
| | (0.440) | (1.265) |
| Asset Specificity·Selling Capabilities | | -0.0868*** |
| | | (0.0246) |
| Asset Specificity·Production Capabilities | | 2.847*** |
| | | (1.042) |
| Relative Price | 4.184*** | 4.171*** |
| | (0.695) | (0.696) |
| Network Performance | -20.027*** | -23.051*** |
| | (4.503) | (3.646) |
| Touristic Area (=1) | 2.024*** | 2.160*** |
| | (0.561) | (0.561) |
| Ground Water (=1) | -1.828** | -1.709** |
| | (0.777) | (0.765) |
| Mixed Water (=1) | 2.902*** | 2.804*** |
| | (0.686) | (0.654) |
| Mixed Treatment (=1) | 3.452*** | 3.773*** |
| | (0.881) | (0.889) |
| Complex Treatment (=1) | 2.677*** | 2.780*** |
| | (0.703) | (0.698) |
| Mixed and Complex Treatment (=1) | 6.370*** | 6.537*** |
| | (1.129) | (1.119) |
| Private Management (=1) | 1.466*** | 1.345*** |
| | (0.454) | (0.459) |
| Inverse Mills Ratio | -0.0668 | -0,712 |
| | (1.120) | (1.157) |
| Constant | 38.43*** | 56.15*** |
| | (7.397) | (10.18) |
| All Other Controls | Yes | Yes |
| Observations | 12,291 | 12,291 |
| R-squared | 0.252 | 0.273 |

Note: Robust standard errors in parentheses with *p<0.10, **p<0.05, ***p<0.01. All other controls include year and regional fixed effects plus all variables presented in Table 2.3 that are not reported in this table. In this table, concurrent sourcing and selling capabilities are rescaled to be between 0 and 100.

We now comment on the two-way interactions of asset specificity with capabilities. Interaction terms show how asset specificity can mitigate or accelerate the impact of capabilities on concurrent sourcing. Consistent with hypothesis 5, we expect asset specificity and capabilities to be negatively correlated. In model (2), the interaction term between asset specificity and selling capabilities has a significant negative impact on concurrent sourcing. The positive impact of selling capabilities on concurrent sourcing is mitigated by asset specificity as hypothesis 5 supports. Furthermore, asset specificity is expected to increase the negative impact of production capabilities on concurrent sourcing. Yet, we find a significant positive coefficient for the interaction term of the production capabilities with asset specificity which is not consistent with hypothesis 5. There can be two explanations for the impact of asset specificity. The first one is that managers that invest in specific investments tend to choose internal procurement rather than external procurement. Another reason is that municipalities with high specific investments are also large municipalities with large production capabilities.

Table 2.6 shows the results of equation (2.4). The identification strategy is based on the study of the impact of an exogenous change in demand for water on production. We exploit here cross-sectional differences in capabilities and transaction costs to measure their impact on the decision to make or buy. We will only comment on crossed variables and not on the main effects that are reported. When we consider production as the dependent variable, we consider the "make" option, unlike the degree of concurrent sourcing that is a proxy for the intensity of the "buy" option.

Models (1) and (2) in Table 2.6 are OLS regressions. In all models, the dependent variable is the volume of units produced by the city $i$ in year $t$. All variables reported in Table 2.6 are independently crossed with the demand

Table 2.6: Production as a Function of Capabilities and Transaction Costs

| Variables | (1)<br>OLS<br>Production | (2)<br>OLS<br>Production |
|---|---|---|
| *Demand*·— | | |
| —·Asset Specificity·Concurrent Sourcing | | 0.170* |
| | | (0.0924) |
| —·Concurrent Sourcing | -1.196*** | -2.088*** |
| | (0.0804) | (0.457) |
| —·Selling Capabilities | 2.050*** | 2.047*** |
| | (0.438) | (0.447) |
| —·Group of Cities | -0.0520** | 0.00142 |
| | (0.0210) | (0.00678) |
| —·Relative Price | 0.159 | 0.162 |
| | (0.0773) | (0.0770) |
| —·Asset Specificity | -0.0036 | -0.0039 |
| | (0.0318) | (0.0326) |
| —·Touristic Area | -0.0114 | -0.0232 |
| | (0.0804) | (0.0820) |
| —·Mixed Treatment | 0.0487 | 0.0460 |
| | (0.0572) | (0.0565) |
| —·Complex and Mixed Treatment | 0.0649* | 0.0651* |
| | (0.0380) | (0.0375) |
| —·Complex Treatment | 0.00545 | 0.00392 |
| | (0.0475) | (0.0476) |
| —·Ground Water | -0.159*** | -0.156*** |
| | (0.0448) | (0.0448) |
| —·Mixed Water | -0.110*** | -0.106*** |
| | (0.0389) | (0.0387) |
| Inverse Mills Ratio | 49.75* | 48.33* |
| | (28.34) | (28.47) |
| Constant | -425.792 | -422.225 |
| | (284.656) | (284.254) |
| All Other Controls | Yes | Yes |
| Observations | 12,291 | 12,291 |
| R-squared | 0.991 | 0.991 |

Note: Robust standard errors in parentheses with *p<0.10, **p<0.05, ***p<0.01. For ease in reading, all other controls include year and regional fixed effects plus all variables presented in Table 2.3 that are not reported in this table and their interactions with demand, except production capabilities that is not interacted as the variable is built using the level of production.

variable. Main effects and all fixed effects are not reported in the table but are included in the regressions. Model (2) includes three-way interactions crossing RBV, TCE proxies and demand. We first comment on the two-way interactions. As expected, contracting capabilities, measured by *concurrent sourcing* has a significant negative impact on production. However, the support for hypothesis 3 is not as strong as in previous models, because *selling capabilities* have a significant positive impact on production while hypothesis 3 would support the contrary. *Production capabilities* is a variable that is built using *production*. In order to test for hypothesis 4, we hence use the *relative price* that is a proxy for production capabilities. The impact is positive but not significant, thus not supporting hypothesis 4.

Asset specificity has a significant negative impact on production in the two models which is not consistent with hypothesis 1. One of the reasons for this negative coefficient is that production and the length of the network are partly correlated[34]. Hypothesis 1 is thus not validated in this model. The proxies for complexity have overall a non-significant or a significant negative impact. This supports hypothesis 2. When internal production is complex, managers tend to favor external procurement that can be more cost-efficient.

We now comment on the three-way interactions of demand, asset specificity and concurrent sourcing. The interaction with concurrent sourcing is positive as predicts hypothesis 5. When asset specificity is important, the impact of contracting capabilities on production will be lower. This is the same for production capabilities. Municipalities with higher levels of asset specificity will experience higher level of internal procurement when demand increases. The results are consistent with those depicted in Table 2.5.

[34]The correlation between the two variables is 0.26 in our sample.

## 2.6 Discussion and Limitations

### Discussion

Once we have established the empirical relationship between capabilities and the outsourcing decision, we should discuss to which theory the results better fit. Both theories are good candidates. On the one hand, asset specificity is a strong incentive to directly manage the public service. On the other hand, municipalities that are used to negotiate contracts are keener on outsourcing, probably because they can avoid ex-post opportunistic behaviour that may appear in the contract.

Our results are consistent with RBV and TCE theoretical results. Intuitively, we would expect capabilities to be mitigated in environment with high level of transaction hazards. Our intuition is confirmed by the empirical analysis. Results demonstrate systematic pattern in the heterogeneity of cities to organize their public services and to respond to increase in demand. However, the results show also that capabilities impact differently cities that have different level of transaction costs.

Cities with prior experience in designing and operating complex and incomplete contracts may find such contracts less costly to write, be more skilled at enforcing their requirements and be more accustomed to ex post adaptation. This contracting experience has a substantial and significant effect on organizational choices. However, because transaction costs differ from city to city, contracting experience will have a declining effect when hold-up risks are more important. The same effect is observed for production capabilities. Production capabilities fosters direct management and production rather than import. The effect is stronger when transaction costs are important.

The contribution of the paper to the theory is that transaction costs do not only vary from a transaction to another but also from a production unit to another even in similar institutional environment. This means that studying transaction costs should not be focused on transaction but also on firms and their capabilities that can evolve across time, something that has been noticed by Teece et al. [1997] for example. This is also critical to the transaction cost literature which usually studies the ideal governance form of organization and their performance. Actually, the outcome of an organizational form depends on the dynamic capabilities of firms. Conversely, the potential performance of firms depends on the level of transactional hazards they have to deal with. Under high level of transactional hazards, production capabilities may not be sufficient to give a clear competitive advantage to a given city.

Moreover, this paper builds on previous literature such as Gulati et al. [2012] that concluded that TCE does not adequately tip the balance in favour of hybrid and corner solutions. The standard governance costs approach developed by Coase [1937] does not account for volumes exchanged in the markets. Concurrent sourcing is assumed to occur for goods that can be similar but with different asset specificity, for example different technologies. Even if we observe corner solutions in the lease-manage decision, we face cities with different levels of production and imports of water. The existence of such differences in how much firms make and how much they buy is not straightforward in the literature. Especially, it was not straightforward to understand that the make or buy decision could be duplicated to different strategical decisions within the same unit of production.

We also complement the resource-based view of the firm by specifying the transaction conditions under which firms make more or buy more a good and how the mix varies. Under assets specificity, firms with high levels of resources will predictably make more and buy less than firms with similar resources but operating on transactions with lower asset specificity. Perhaps, one of the most important insights to arise from a consideration of concurrent sourcing is the value of systemic firm level analysis coupled with transaction level analysis.

We finally assess the relative performance of utilities that make and buy rather than simply make. We simply test the impact of concurrent sourcing on several performance indicators like price for a standard bill, marginal price, water quality and network performance. Results are reported in Table 2.7. All four models are OLS regressions including various fixed effects. Because of missing data, the number of observations varies from a model to another. We observe that concurrent sourcing is associated with higher price level as depicted in models (1) and (2) but stronger quality standards as illustrated models (3) and (4) show. This raises a puzzle as the sourcing production unit would be expected to do so when its suppliers' production costs are lower. There can be various explanations to this trend. The first one is that for a given complexity making internally is always cheaper. This is especially true for water production as - contrary to other goods - there is no competitive advantage from external procurement in terms of knowledge or innovative competition. Moreover, the prices charged to the sourcing firm may be higher than those in internal procurement, due to the risk borne by having transaction costs in implementing contracts and uncertainty in the transferred volume. In this case, securing supply flows is a sufficient reason to source both internally and externally and the price premium is comparable to an insurance premium. The final reason is that in water markets, as in many commercial transactions, supply markets are relatively thin due to some specific investment or capabilities required to manage contracts and thus sourcing firms have few potential external suppliers. This raise the trade-off between specific investments required for concurrently source a good and capabilities to negotiate with limited suppliers that we approximated with the model of concurrent sourcing. More investigation, using detailed plant-level data, could be undertaken to deepen these points.

Table 2.7: The Efficacy of Concurrent Sourcing

| Variables | (1)<br>OLS<br>Price | (2)<br>OLS<br>Marginal Price | (3)<br>OLS<br>Water Quality | (4)<br>OLS<br>Network Performance |
|---|---|---|---|---|
| Concurrent Sourcing | 6.114*** | 0.060*** | 0.010 | -0.049*** |
| | (1.677) | (0.011) | (0.008) | (0.014) |
| Selling Capabilities | -0.134 | -0.026 | -0.017 | -0.002 |
| | (2.748) | (0.018) | (0.014) | (0.020) |
| Production Capabilities | -1.821*** | -0.007*** | 0.003 | -0.043*** |
| | (0.412) | (0.002) | (0.002) | (0.009) |
| All Other Controls | Yes | Yes | Yes | Yes |
| Observations | 13,002 | 13,002 | 7,595 | 12,714 |
| R-squared | 0.411 | 0.336 | 0.226 | 0.368 |

Note: Robust standard errors in parentheses with *p<0.10, **p<0.05, ***p<0.01. For ease in reading, all other controls include all variables used in previous regressions, except interactions. The number of observations falls as we do not have always complete information on public utilities' performance.

Another reason is that utilities that concurrently source are forced to import expensive water. Why then do utilities decide to make and buy rather than make? Apart from production capabilities and access to other sources of water, the reason could lie in the will to increase subcontracting capabilities in order to mitigate hazards at the public service level.

The transaction hazards and the framework studied in this paper are specific to the residential water industry. The theoretical implications can be however expanded to other public utilities or to similar frameworks. The water sector is nonetheless particularly interesting because of the nature of the good. More broadly, the theoretical logic applies to any contracting decisions. Generalization to other utilities can although be drawn. For example, results are somewhat similar to those of Fabrizio [2013] on electricity in the US.

## Limitations

There are several limitations to this paper. One of the limitations of our paper is that we cannot explore the origins of utilities' capabilities. Consequently, we cannot really measure how capabilities arise as a result of managers' strategic choices. First, capabilities can result from historical decisions of the municipality. Early investment decisions in networks or early outsourcing can explain the path of capability development that influences across time the make-or-buy decision and ultimately performance of the public water service.

Another limitation to this research is that we do not give much attention to the dynamic capabilities of firms as developed by Teece et al. [1997] for example. The reason is simple. The nature of the sector studied does not reveal much about adaptation issues and expansion paths, at least if we consider it at the city-level as we did. Related to these dynamic capabilities are the studies by Argyres and Mayer [2004] and Argyres et al. [2007] who studied the evolution of complex contracts between two partners in the software industry. Argyres and Mayer [2004] underlined the importance of learning to contract as a means to learn how to collaborate. They argued that contracting experience sensitize managers and their organizations to potential disturbances occurring during the duration of the contract. Slowly, the partners learned about both the effective matching between combinations of transaction features and combinations of contractual provisions with different levels and types of detail. Argyres et al. [2007] found that the existence of learning spillovers is suggested by the finding that contingency planning in prior contracts is associated with more detailed task description in subsequent contracts with the same partner, controlling for key transaction characteristics, and vice versa. The unexpected finding of the author was that task descriptions become less detailed over time. Our data did not contain detailed information to measure contractual completeness. Indeed, an important feature of learning to contract is that it impacts not only the number of contracts but also the evolution of the content of the contracts.

One of the limitations of our study comes from the nature of our data. We know whether contracts are signed for buying and selling water. However, we only have the identity of buyers importing water and the identity of sellers exporting water. It would have been interesting to investigate patterns in transaction between municipalities. We would especially expect utilities to trade water with utilities that are managed by the same firm. One of the most important features of concurrent sourcing is that it can impact the market structure of the industry. The share of concurrent sourcing can change the industry concentration and thus market power of private firms that trade water at the utility-level. At the local level, it would be interesting to see if utilities trade with utilities that have the same operator. Especially, it would be interesting to know whether some forms of price discrimination appear in these cases.

One of the consequences of water trades that is not studied in this paper, due to missing information, is that water trades can have a strong impact on water allocation and conservation. More detailed observations on selling and buying prices and on the hydrological conditions could lead us to raise the question of efficient pricing of water trades on the spot market and the potential externalities of water trades. Positive externalities include allocative efficiency from developing markets to trade water. Negative externalities include the impact of resource uses on water left in stream for recreation, riparian, wetlands restoration and the fat that using up non-renewable water today will leave less for tomorrow.

Reverse causality that can exist between subcontracting and contracting capabilities is worrisome in our models. Indeed, we assume that cities with high subcontracting experience favour contracting out the management of the public service while it could be the opposite. Effectively, one could argue that cities that contracted out their water public service have superior skills to manage subcontracting. However, we argue here that water trades are anterior to the lease-manage decision, especially because utilities are structurally buying or selling water.

## 2.7 Conclusion

This paper integrates transaction cost economics with the resource-based view of the firm to examine how cities' capabilities and transaction hazards influence governance decisions in public-private contracting schemes. We focus here on two levels of governance choice, the lease-manage decision of the public service and the make or buy decision at the utility level. We demonstrate that the impact of firm capabilities on two tiers of governance choice varies with the level of transaction costs. Based on data for roughly 4,000 cities over four years - 1998, 2001, 2004 and 2008 - we find that firms with prior contracting experience and low production capabilities tend to lease rather than manage their public services and to make rather than buy when demand increases. We also find that transaction hazards mitigate contracting capabilities and increase the impact of production capabilities on governance decisions. These findings suggest that firm heterogeneity is a significant factor in governance decisions and that firm capabilities and their interactions with transaction hazards demand superior consideration in the study of firm governance.

Our contributions are twofold. First, we document the make-or-buy decision in public utilities at several levels of the organization and the industry.

We find that a basic framework using transaction cost economics, which supports that transaction characteristics impact firms' governance choices, and the resource-based view of the firm, which considers firm heterogeneity as a product of firms' relative resources and capabilities, can explain the organizational choice made by utilities. Second, we focus on why utilities make and buy the same good and on the consequence of this organizational choice on performance. We find that make-and-buy is associated with higher prices but higher quality standards. This paper has several implications for managers. When considering their sourcing options, public managers should be aware of their capabilities to make and buy water. Such capabilities can be very important to mitigate hazards such as ex post renegotiation at the local level. Yet, private and public managers must be aware that utilities and cities need to have a thorough understanding of the base technologies for the complementarities in order to undertake concurrent sourcing.

Some unobserved factors would deserve more attention, among them, the possibility that past governance choices provide learning and capabilities that are dynamic and can in turn influence future governance decisions, especially among firms operating in an environment with a lot of transactional hazards. Further research should focus on collecting data on these subcontracts to analyze the impact on the market structure of the make-and-buy decision.

## Appendix

Table 2.8: Results from the Selection Equation

| Variables | Probit Interconnected |
|---|---|
| Semi-Urban | 0.218*** |
| | (0.0285) |
| Urban | 0.676*** |
| | (0.0433) |
| Touristic Area | -0.202*** |
| | (0.0378) |
| Limitation | -0.018 |
| | (0.0496) |
| Constant | 1.402*** |
| | (0.064) |
| Regional FE | Yes |
| Observations | 19,454 |
| R-squared | 0.149 |

Note: Robust standard errors in parentheses with *p<0.10, **p<0.05, ***p<0.01.

# Part II

# Promoting Efficiency and Equity in Public Services

Chapter 3

# Efficiency in the Public & Private French Water Utilities: Prospects for Benchmarking*

## 3.1 Introduction

In industries such as energy, electricity, water and wired phone service, which are candidate for natural monopoly and where price schedules can have strong economic distortions, there is a long-time debate on the issues of utility ownership, regulation and technical efficiency. Fabrizio et al. [2007] for example evaluate the long-term impact on the industrial efficiency of privatization in electric utilities in the United States and find a significant positive impact of privatization on cost efficiency. Davis and Muehlegger [2010] discuss ownership as a determinant of price-efficiency - defined as marginal cost pricing - in the

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United States natural gas industry. Water supply industry exemplifies these issues. In industrialized countries, local authorities are responsible for water provision on behalf of their citizens. The service can be managed in-house or be outsourced to a private operator using a public-private arrangement. Whatever the management system, the local authorities set the objectives - such as an uninterrupted service, good water quality and affordable prices - and have to enforce them.

Debates about the relative technical efficiency of private and public management frequently arise. In France for example, in 2009, a year after the municipal elections, the left-winger mayor of Paris decided not to renew the city's water provision contract with two private operators and to directly manage the public service. The municipality is now in charge of providing water for the 2 million inhabitants of the city. In the beginning of 2011, after a year of direct public management, the mayor announced that good performances will lead to a decrease by 8% of the drinking water price in Paris from july 2011 on. Consequently, other French public authorities decided to directly provide water to their users without contracting out with private operators arguing that public management is more efficient for public services. In other countries, we find the same debate about public and private efficiency (see for example Bhattacharyya et al. [1995] on the USA, Estache and Rossi [2002] on Asia and Kirkpatrick et al. [2006] on Africa, Garcia-Sanchez [2006] on Spain, Saal and Parker [2000] on Wales and England, Zschille and Walter [2012] on Germany).

In France, where there is no national regulator for water, water distribution is increasingly coming under scrutiny by operators, policymakers, and researchers. Benchmarking is a tool that is widely used in various countries and sectors to provide information and incentives to utilities (see for instance

Shleifer [1985]). While early applications of benchmarking techniques have been practiced in the UK, most comparative studies between public and private management in the French water sector such as Carpentier et al. [2006] and Chong et al. [2006] use econometric methods. This is partly due to missing data on costs, revenues and performance or quality indicators. Since the 2007 decree and the implementation of the *French National Observatory of Water and Aquatic Environments* (ONEMA) the same year, the idea of a benchmarking of water services in France got more popular. The *Fédération Nationale des Communes Concédantes et Régies* (FNCCR), an association of municipally elected persons who manage public services, has already financed two benchmarking studies on 31 voluntary French water provision services using 2008 and 2009 datasets. By the same token, the *Professional Association for Water Companies* (FP2E for *Fédération Professionnelle des Entreprises de l'Eau*), a group of private firms operating in the water and sewage sector, also collects data and fund studies (Boston Consulting Group [2007]) on the relative performances of direct and delegated management. Finding the regulating tools that will reduce the information asymmetry between local authorities and water companies and promote the performance objectives in the water industry has become a broadly shared goal. Assessing relative performances can become a valuable regulatory instrument and begins to gain popularity in France.

This paper addresses the relative technical efficiency of 172 public and private water suppliers in France by computing the best practice frontier of our sample. To identify managerial efficiencies, we evaluate the ability of water producers to minimize their revenues in the provision of a set of outputs, relative to the performance of other producers in our comparison set. We consider that efficient water services operate with low revenues, thus covering their costs but downsizing their margins in order to limit distortions. However, efficiency depends also on the characteristics of the environment in which production is carried out. Moreover, hazards such as "luck" must be unbundled from managerial efficiencies. We take into account these effects by considering a set of environmental variables that can impact technical efficiencies.

Our empirical approach is different from previous studies on French data. To control for hazards and structural differences, we mix a non-parametric approach (Data Envelopment Analysis, DEA) with a stochastic model (Stochastic Frontier Analysis, SFA) in a three-stage approach introduced by Fried et al. [2002]. The three-stage model is the following. In the first-stage, a conventional input-oriented DEA using only inputs and outputs is applied to obtain initial measures of producer performance. In the second-stage, we regress the slacks of the first-stage against the environmental variables and an error term using a Stochastic Frontier Analysis (SFA). This method allows us to purge the managerial inefficiencies from the possible environmental effects and statistical noise. Finally, the third-stage re-evaluates producer performance and provides improved measures of managerial efficiency, since the data have been purged of both environmental effects and statistical noise. We then rank decision making units (DMU) according to their efficiency scores that ranges between 0 and 1.

This paper contributes to the previous literature in two different ways. First, in addition to traditional measures of technical efficiency, we consider some measure of quality and environmental variables to assess the performance of DMUs. Network performance is important because it usually warrants civil society, especially as water is being considered a scarce resource. Secondly, we mix different benchmarking models to contribute to the literature on public-private management comparison. Our results show that utilities under private management are on average more complex to manage. Accounting for environmental variables increase efficiency by 0.1 under private management while it only lifts up efficiency by 0.059 for public management. However, even after having taken into account environment variables and statistical noise, private management remains on average less efficient than public management. Public management has an efficiency score of 0.883 against 0.823 for private management. As a summary, even if the technical efficiency gap is narrowing after correcting for structural differences, it remains significantly positive. This gap partly results from a widespread technical efficiency of DMUs under private management.

The outline of the paper is the following. Section 3.2 reviews relevant literature with respect to the applied methodologies. Section 3.3 provides a general description of the regulatory regime and the institutional framework for the French water industry. The model specification is set out in section 3.4. Section 3.5 focuses on variables along with the arguments that support their choice. Empirical results are presented and discussed in section 3.6. We finally use econometric methods to check the robustness of our results in section 3.7. A brief conclusion follows.

## 3.2 Related Literature

A large number of studies uses a benchmarking method to evaluate the efficiency of water utilities in industrialized and developing countries. Alongside the empirical research into the measurement of efficiency, an equal amount of attention has been directed to the factors that can influence efficiency. One of the key purposes of studies on efficiency has been to examine the role of ownership.

In industrialized countries for example, Bhattacharyya et al. [1995] using a translog variable cost function on 221 US water utilities, find that US publicly owned water utilities are more efficient. The same result is found by Shih et al. [2004] who apply DEA to two US datasets. Garcia-Sanchez [2006] uses a four-stage approach to estimate technical and scale efficiency of 24 Spanish municipal water supply agencies. Running three best-discriminating DEA models with nearly identical efficiency scores, they find that only population density - not ownership - has a statistical significant impact on inefficiencies. Using case studies in various countries, Hall and Lobina [2004] and Hall and Lobina [2005] show that private management often leads to higher prices than public management. However, the authors do not give clear-cut justifications to the price-gap between public and private management. The same impact of private management on price is found by Carpentier et al. [2006] and Chong et al. [2006] in France. Studying 5,000 French municipalities in 2001, Chong et al. [2006] find that private management is associated with a premium of 11 euros for a standard bill. Carpentier et al. [2006] used treatment effects on 3,782 municipalities in 2008 and found that private management is associated with higher prices because of more complex water utilities.

In developing countries, some studies find a slight positive impact of private ownership on company efficiency. Kirkpatrick et al. [2006] use DEA and SFA to determine the impact of ownership structure on efficiency performance of 110 water utilities in African countries. Higher relative efficiency is shown for privately owned utilities, when using a DEA method, whereas no statistically significant results for the impact of ownership is found with SFA. Estache and Kouassi [2002] estimate a Cobb-Douglas production function for 21 African water utilities for the period 1995 and 1997. In a second-stage, they use a Tobit model to relate resulting inefficiency scores to governance and ownership variables. Their results indicate that private ownership significantly decreases inefficiency. However, their dataset contains only three privatized firms while corruption and governance seem far more important in explaining efficiency differences between firms than the ownership variable. No significant differences between efficiency under public and private ownership are observed by

Estache and Rossi [2002], who estimate a stochastic cost frontier modeling on data from 50 water utilities in developing and transition countries in the Asian and Pacific region.

Instead of comparing public and private water utilities operating at the same point of time, another body of work focuses on the impact of privatization on the efficiency and productivity of the sector, mostly in the UK. Saal and Parker [2000, 2001] study the privatization of water utilities in England and Wales in 1989. They expect privatization to improve efficiency on the premise that it removes soft-budget constraints, eliminates any political or special interest group interference associated with public ownership, exposes utilities to the market for corporate control, and incentivises management and employees with performance pay structures and the market for managerial talent. Using cost function and Total Factor Productivity (TFP) analyses to a panel of ten UK private companies, the authors conclude that there is no statistically significant reduction in the trend growth rate of total costs following privatization using cost function and no changes in productivity after privatization using TFP.

One challenge with those studies is the appropriate recognition of the differences in public and private strategies. While there is a clear similarity in the specification of inputs and outputs, one might argue that private and public managers do not serve the same goals. As a matter of fact, and as noted by a recent paper by Zschille and Walter [2012], private managers can be tempted by excessive pricing, leading to distortions (such price distortions in regulated utilities are also discussed in Borenstein and Davis [2011] and Davis and Muehlegger [2010] for example) between producers and consumers, but also on connected markets (here sanitation for example). While cost-based analyses focus on management inefficiencies, we argue here that using revenues leads to a broader analyses coupling the benchmarking of managerial inefficiencies and pricing strategies.

## 3.3 The Water Sector in France

### The provision of water in France

In France, municipalities must provide local public services that have public good characteristics. This provision can be made by the municipality alone or by a group of municipalities that collectively engage to provide one or several public services. As there is no national regulator for these services, local public authorities define the general principles governing those services on behalf of their citizens: they monitor prices, control entry and exit of firms into the market, organize competition and ensure uninterrupted service. Regulation has thus been replaced by a contract in the case of a private operator or a decision of the municipality board in the case of public operation. In the case of delegated management, public authorities face the classic regulatory problem: they are in an information asymmetry position and have few tools to carry out their essential tasks. Water supply is one of these public services. Water supply is a broad subject implying four public services. On the one hand, water provision refers to the production and the distribution of water; on the other hand, sewerage implies wastewater collection and treatment. Due to potential scope economies, water provision and sewerage can be run by the same operator[35] but through two separated contracts.

Furthermore, rules have been defined to ensure that standards are re-

[35]An official report by Dexia, a French financial intermediary, states that 63% of French medium-sized cities contract out the services of drinkable water treatment and distribution and 58% also contract out their sewerage services. It is however difficult to have a precise estimation of how many municipalities and communities have contracted out both services with the same operator.

spected during the operation to limit the potential opportunistic behavior of operators. These rules support water quality, duration of contracts and information about management and provision quality. In the case of water quality, a precise definition of more than 60 verifiable quality parameters has been set by the 1992 water act to ensure that water services, would they be private or public, respect quality standards. Consequently, water quality is respected and is rarely below a 95% score of conformity to the standards of the microbiological analysis. Moreover, limits on duration have been implemented and management and provision information is now required to be publicly reported. To ensure that competition between operators arises, the "*Barnier Law*"(1995) gives a clear limitation to the duration of contracts and includes an automatic renegotiation of the contract every five years. To struggle against information asymmetries, the executive power passed a decree in 2007 that forces municipalities and communities to provide 14 performance indicators in the mayor's *Annual Report on Prices and Service Quality* (RPQS in French). These performance indicators and other data about water and sewerage services are collected by the *French National Observatory of Water and Aquatic Environments* (ONEMA in French) to provide data in order to inform users and citizens about their water services.

### The institutional framework of water industry in France

In France, each local public authority may choose a particular contractual form from the differentiated set of alternatives. Although some municipalities manage production through a *direct public management* and undertake all operations and investments needed for the provision of the service, the hiring of a private operator, independent of the local government, to manage the service and operate facilities is common.

In the latter case, the local public authority may choose to involve an outside firm in the operation of the service choosing a *gerance contract* in which it pays an external operator a fixed fee, or an *intermediary management contract*, i.e. a gerance contract but with a small part of the company's revenues depending on its performance. Such contracts provide few incentives to reduce costs and transfer few risks and decision rights to the private water company. Between a *gerance contract* and privatization, there are two main *delegated management* contracts [36]. *Lease* contracts are characterized by investments to maintain the network and financial compensation directly through customer receipts. In the *concession contract*, the external company also undertakes construction risk, as it must finance a large part of investments over the duration of the contract. *Lease* and *concession* contracts differ from the previous ones in that they give companies incentives to reduce costs, and companies share risk in exchange for greater decision rights and claims on revenues.

The institutional framework to select the private partner is the following. Since the "*Sapin law*" (1993), if the public authority chooses a lease or a concession contract, it selects its partners in two steps. First, the public authority launches a classical invitation to tender that is open to all interested private water companies. Second, there is a negotiation phase between the public authority and potential entrants that it shortlisted. At the end of the negotiation, the public authority chooses its final partner for the duration of the contract. The selection of the private company follows the *intuitu personae* principle according to which the municipality or the community sets a list of criteria to select the firm that is considered as the best partner. However, the number of bidders remains low, around 1.9 for each bidding process (Guérin-Schneider and Lorrain [2003]).

[36] Our sample has only *delegated management contracts*.

## 3.4 The model specifications

### Methodology

In 1957, Farrell introduced a data envelopment methodology[37] for the measurement of economic efficiency. From an input-oriented perspective[38], technical efficiency is associated with the ability to produce on the efficiency boundary of the production possibility set given a predetermined quantity of output. DEA is useful because the researcher does not need to make any assumption about the functional link existing between inputs and outputs.

The basic DEA model described evaluates economic efficiency using traditional input and output variables but it does not consider the potential impact that environmental factors may have on producers' performance measurement. Several models have been developed in order to incorporate environmental effects into a DEA-based performance evaluation[39]. One possible approach is to include the environmental variables directly into the linear programming formulation either as non-discretionary inputs, outputs or neutral variables, according to the circumstances (Ferrier and Lovell [1990]). This requires that further linear programming constraints be included. As a consequence, only few environmental variables can simultaneously be taken into account to avoid excessive restriction of the reference set. Contrary to the DEA approach, the stochastic frontier analysis (SFA) accounts for statistical noise and environmental variables in measuring efficiency. However, this type of analysis demands important datasets on inputs costs such as labor costs,

[37]For a comprehensive description of DEA models, see Charnes et al. [1978], Thanassoulis [2000a,b], Charnes et al. [1994] and Cooper et al. [2004]

[38]In principle, economic efficiency may be measured using an input or an output-oriented approach. In the first case, the input use is minimized given a certain amount of output, while in the second the output is maximized for a given level of inputs. Generally, the adoption of an input-oriented framework is preferred for public utilities as demand may be seen as exogenous

[39]See Coelli et al. [1998] for details on these models.

capital costs or energy costs.

A possible approach to better evaluate producer performance is to adopt a multi-stage DEA analysis. This ensures that the comparison is made among units which operate under similar environmental conditions, thus eliminating the environmental effects from the single company's performance assessment. Another group of models is based on two-stage mixed approaches which imply a regression-based second stage. These models involve solving a DEA problem in a first stage using traditional input and output variables in order to calculate initial efficiency measures. The efficiency scores are then regressed using ordinary least squares (OLS) upon a set of environmental variables in a second stage, the objective being to determine the signs, as well as the significance of the coefficients of the environmental variables (see for instance Bhattacharyya et al. [1997]) by adjusting the first stage efficiency scores.

For their part, Fried et al. [1999] introduced a three-stage approach where the initial DEA efficiency scores based exclusively on output and input are then regressed in the second stage using a Tobit upon a vector of environmental factors. Predicted values of the impact of the environmental effects can then be computed. In the third stage, the original data are adjusted to account for the effect of environmental variables and DEA is re-run in order to obtain new DEA scores unaffected by environmental characteristics. We should underline that Tobit regressors using efficiency scores as dependent variable can give biased results for at least two reasons. The first one is that the dependent variable - the inefficiency remaining from the first stage - is purely constructed. The second reason is linked to the first one. As technical efficiency scores are bounded by 0 and 1 by construction, the variable does not capture all the variance of the existing inputs.

Both OLS and Tobit are however unable to account for the role of statistical noise on efficiency. However, as noted by Erbetta and Cave [2007], both these approaches are deterministic and so they fail to take into consideration the effects of statistical noise on efficiency performance. In order to embody the action of both environmental variables and statistical noise upon efficiency, we adopt, like Erbetta and Cave [2007] a three-stage approach proposed by Fried et al. [2002]. This mixed approach which combines DEA and SFA makes it possible to obtain a measure of the intrinsic managerial performance, separately both from the impacts of the environmental characteristics in which production takes place and from random noise. As SFA is regression-based, it can isolate managerial inefficiencies from environment effects and statistical noise in the second stage. In the last stage, producers' inputs are adjusted to account for the environmental effects and statistical noise identified in stage two and DEA is run again to re-evaluate producer performance.

### Model Set-Up

The initial producer performance evaluation is conducted using a conventional input-oriented DEA analysis, using input quantity data and output quantity data only. The basic DEA model can be expressed as the following linear programming problem:

$$\begin{cases} \min_{\theta,\lambda} & \theta \\ \text{s.c} & -y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & \lambda \geq 0 \\ & e^T\lambda = 1 \end{cases} \tag{3.1}$$

with $y > 0$ is a producer's $i$ $M \times 1$ vector of output; $x > 0$ is a producer's $N \times 1$ vector inputs used by the DMU $i$ ; $Y = [y_1, ..., y_I]$ is a producer's $M \times I$ matrix of outputs of the $I$ DMUs in the comparison set; $X = [x_1, ..., x_I]$ is an $N \times I$ matrix of inputs used by the $I$ DMUs of the sample; $\lambda = [\lambda_1, ..., \lambda_I]$ is an $I \times 1$ vector of intensity variables; $e = [1, ..., 1]$ is an $I \times 1$ vector for the $I$ DMUs of the sample; $0 \leq \theta \leq 1$ is an efficiency score measure.

The first step thus consists in solving program (3.1). However, actual technical efficiencies are likely to be attributable to some combination of managerial inefficiencies, environmental effects, and statistical noise, e.g. "bad luck" or a biased error term, and it is desirable to isolate the three effects.

In a second step, the total excess (radial plus non-radial) of inputs (*slacks*) computed in the first stage (noted $S_{ni} = x_{ni} - X_n\lambda \geq 0$) are regressed against the environmental variables adding an error term, using the SFA method. $S_{ni}$ is thus the excess of inputs resulting from the usage of input $n$ by the DMU $i$. $X_n$ is the $n^{th}$ column of $X$ and $X_n\lambda$ represents the optimal projection $x_{ni}$, i.e. the value that the input should reach so that the DMU is considered to be efficient. The belief from the DEA first-stage is that total slacks reflect initial managerial inefficiency. However, we interpret these slacks more broadly, as being composed of three effects: environmental influences, managerial inefficiencies, and statistical noise arising from measurement errors in input and output data used to generate the first stage slacks. The main advantage of using SFA rather than a standard econometric method such as Tobit or OLS in the second-stage is that its error term is asymmetric. Consequently, it allows to dissociate the environmental variables (here the regressors) from managerial inefficiencies (the one-sided error component) and from statistical noise (the symmetric error component). Independent variables are $K$ environmental variables : $z_i = [z_{1i}, ..., z_{Ki}], i = 1, ...I$. The $N$ regressions (one for each *input* excess) are written as follows, with $n = 1, ...N$ and $i = 1, ...I$ :

$$S_{ni} = f^n(z_i; \beta^n) + \nu_{ni} + u_{ni} \tag{3.2}$$

$f^n(z_i; \beta^n)$ represents the frontier of inputs slacks. The $\beta^n$ are the estimated parameters by the software. $\nu_{ni}$ measures the statistical noise whereas $u_{ni} \geq 0$ stands for the managerial inefficiencies of the DMU. The stochastic frontier is measured by $S_{ni} = f^n(z_i; \beta^n) + \nu_{ni}$. As $u_{ni} \geq 0$, this stochastic frontier represents the minimum *slacks* that can be reached by the DMUs. All inputs slacks above this frontier will be considered as managerial inefficiencies of DMUs. The idiosyncratic error term $v_{ni}$ is independently and identically distributed $v_{ni} \sim N(0, \sigma^2_{vn})$, while $u_{ni} \sim iid\ N^+(\mu^n, \sigma^2_{un})$ (zero-truncated normal law). $v_{ni}$ and $u_{ni}$ are indenpendently distributed between them and regarding regressors. The $N$ regressions (3.2) are estimated using a maximum likelihood. For each regression, parameters to be estimated are $(\beta^n; \mu^n; \sigma^2_{vn}; \sigma^2_{un})$. As noted by Fried et al. [2002], there are at least two virtues of using SFA in the second-stage. First, it is not necessary to assume the direction of the impact of any environmental variable on producer performance prior to the analysis. Second, the framework permits the environmental variables, statistical noise and managerial inefficiency each to exert different impacts across inputs.

We now consider how to use the results from the second-stage to adjust producers' inputs for the variable impacts of different operating environments and random statistical noise. The essence of the adjustment lies in the fact that producers operating in relatively unfavorable environments, and producers experiencing relatively bad luck, are disadvantaged in the first-stage DEA performance evaluation that does not take these factors into account. One way to level the playing field is to adjust upward the inputs of producers who have been advantaged by their relatively favorable operating environments or by their relatively good luck. Producers' adjusted inputs are constructed from the results of the second-stage SFA regressions by means of:

$$x^A_{ni} = x_{ni} + \left[max_i \left\{z_i\widehat{\beta}^n\right\} - z_i\widehat{\beta}^n\right] + \left[max_i \left\{\widehat{\nu}_{ni}\right\} - \widehat{\nu}_{ni}\right] \tag{3.3}$$

with $n = 1, ...N$ and $i = 1, ...I$. $x^A_{ni}$ is the adjusted input ; $x_{ni}$ is the observed input in the dataset. $\left[max_i\left\{z_i\widehat{\beta}^n\right\} - z_i\widehat{\beta}^n\right]$ put all DMUs in the same operational environment. $[max_i\{\widehat{\nu}_{ni}\} - \widehat{\nu}_{ni}]$ put all DMUs in the unluckiest environment. Corrections differ across utilities and the considered input.

Therefore, from the $\widehat{E}\left[\nu_{ni}/\nu_{ni} + u_{ni}\right]$, we derive the statistical noise:

$$\widehat{E}\left[\nu_{ni}/\nu_{ni} + u_{ni}\right] = s_{ni} - z_i\widehat{\beta}^n - \widehat{E}\left[u_{ni}/\nu_{ni} + u_{ni}\right] \tag{3.4}$$

with $n = 1, ...N$ and $i = 1, ...I$. This equation gives the conditional estimators for the $\nu_{ni}$ included in equation (3.3). $\widehat{\beta}^n$ is useful to estimate the contribution of each environmental variable observable for the *slacks*, while parameters $(\mu^n; \sigma^2_{\upsilon n}; \sigma^2_{un})$ allows us to separately estimate managerial inefficiencies and statistical noise *slacks*. When $\gamma^n = \sigma^2_{un}/(\sigma^2_{\nu n} + \sigma^2_{un}) \rightarrow 1$, managerial inefficiencies have a stronger effect than statistical noise, while it is the contrary when $\gamma^n \rightarrow 0$.

In the third-stage, we repeat stage 1 with the adjusted inputs that take into account the observable environmental variables and statistical noise. The output of stage 3 is a DEA-based evaluation of producer performance couched solely in terms of managerial efficiency, purged of the effects of the operating environment and statistical noise.

### Outliers' Detection

In DEA models, the efficiency of a DMU is evaluated relatively to a reference set comprised of all sample observations, including itself. As most efficient DMUs drive the efficiency frontier, it is sometimes necessary to peel off a fraction of the observations to obtain more reliable production frontier estimates. Some of the DMUs might be considered as outliers as they drive upward the efficiency frontier and thus drive downward the average score. DEA is thus sensitive to outliers or extreme observations in the data and a profound validation of the data is necessary.

A first attempt for identifying outliers has been made by Timmer [1971] who suggests discarding a certain percentage of efficient observations from the sample and re-estimating the production frontier using the remaining observations. All the difficulty lies in the capacity to correctly select the outliers. Banker and Gifford [1988] use another procedure based on contamination of efficiency scores by super-efficient outliers. For each observation $i$, the idea of the super-efficiency approach is to solve the linear program given in equation 3.1 by only using all observations $k = (1,...,K)$ other than $i$, i.e. $k \neq i$ as possible peer units. The observation $i$ is not included in the reference set and can have a score greater than 1, i.e. considered as super-efficient, as it can not be a reference for itself. This method is useful to detect outliers that do not stand at the frontier. The drawback is that it needs to repeat *I-1* DEA linear programming which is inappropriate for large samples.

In this paper, we use a simple method to detect outliers (see Tran et al. [2010]). We compute for each observation two simple indicators. First, we consider the number of times that an observation is used as a reference[40]. Second, we compute the cumulative weight of efficient DMUs across all constructed efficient sets. As we use a variable returns to scale (VRS)[41] the frontier consists in a convex combination of inputs and outputs of the most efficient DMUs. An easy way to detect outliers is then to use a graphical representation of the number of times that a DMU is used as a reference and the cumulative weight of the observation across the efficient sets. We then drop outliers and

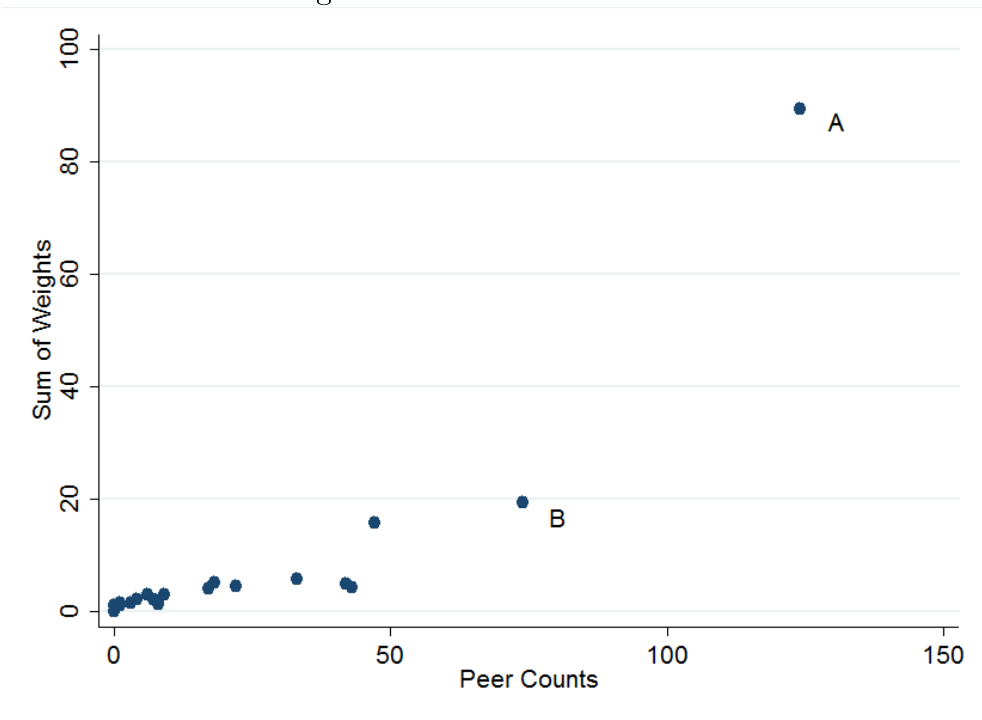
[40]Indeed, the DEA method gives for each inefficient DMU the DMUs that are used as references to compute its technical efficiency. Efficient DMUs, i.e. those which determine the efficiency frontier, can thus be quoted as references for inefficient DMUs.

[41]See Banker et al. [1984] for a detailed explanation. The VRS hypothesis is the less restrictive hypothesis on returns to scale.

re-run the first-stage until the results are stable. Using this simple method, we dropped five observations after having repeated the process three times[42].

Figure 3.1 depicts the link between the number of times a DMU is used as a reference and the sum of weights for the first round of outliers detection. All efficient DMUs are represented in this graph. As one can see, three outliers are easily detected. As there are no clear rules for defining what is an outlier, we decided to graphically select outliers and not to drop more than two variables at each stage. In this case, DMUs A and B are identified as outliers and are then removed from the dataset. In the following section, we present the dataset.

Figure 3.1: Outliers Detection




Note: Outliers are defined as DMUs that push up the efficiency frontier. As one can see, outliers are here A and B, not only because they are often used as peers but also because their weights are important in the definition of the frontier.

[42]We first dropped two utilities under private management. We then dropped a utility under public management and we finally found that two other utilities under private management were outliers.

## 3.5 Data

A data collection has been launched to get the 325 biggest French water services 2009 *Annual Reports on Prices and Service Quality* (*RPQS*). When we could not access the Annual *RPQS*, we used the 2009 *Delegate Annual Reports*, a confidential compulsory annual report made by the firm for the municipality. Like other studies, we focus only on the water service and we do not consider the sewerage one for two reasons. First, a benchmarking on sewerage activities would be constrained by a lack of comparators. Second, we lack data on sewerage services that are sometimes managed by another operator or under another organizational form. We managed to get 297 reports.

One problem that arose during data collection is that reports do not systematically present data in the same way. For example, performance indicators can be computed at city-level, at contract-level or at territory-level. In the latter case, we have information for a bunch of contracts covering several neighbor cities and managed by the same firm. The main criterion to distinguish producers is the contract-level approach. However, sometimes we only have data for the main city of the contract or for the bunch of connected contracts of a single firm. More complicated is the scenario when we have data for the territory with different firms and organizational forms to manage the local utilities. In this case, we considered the utility as public (private) if a majority of connections are managed by a public (private) operator. Because of missing data, our unique sample for this study - OSEA - is made of 177 observations before outliers' detection. In the following subsections, we present the selected variables and their construction when necessary.

### Dependent variables

We use net revenues as a dependent variable. Utilities' revenue mainly depends on price paid by consumers and the number of cubic meters billed, but it also includes other products and profits from works on the networks. In France, the price of water is divided between a fixed-fee and a variable part depending on the consumption pattern of the user. A part of the profit coming from water sales can be paid back to the community or to the municipality in accordance with the contractual design. The final price paid by consumers also includes several taxes transfered to the public water agencies and to the State. As these taxes are set according to the regulation statutory, it does not reflect the service's performance. We thus use as an input the net revenue of the water service excluding revenues coming from other products, works on the networks, product of public taxes and exports to other municipalities. The remaining part represents the revenues from the water sales that are shared between the private water company and the public authority. Net revenues cover costs and include a margin captured by the private firm when the management is private and by the public firm when the management is public.

Most of benchmarking studies in the water industry use operating costs as the dependent variable (see for instance Thanassoulis [2000a,b] in the case of water companies in England and Wales). However, we were not able to collect enough information on this variable as it is often not written in reports and non comparable between public and private management. Indeed, depreciation rules for example render impossible the comparison between costs in public and private management. Moreover, using revenues is meaningful as the price of water must cover the production costs, the so-called "water pays water" principle: under private management, the price is jointly set by the municipality and the firm, following operator costs; under direct management the price is decided by the municipality following its costs.

By including the utility's revenues as an input, we first assume that revenues reflect operating and capital costs plus a mark-up. We believe that high mark-ups are distorsive and reveal managerial inefficiencies. Debates on water in France, as in other industrialized countries, usually insist on the difference between public and private management in terms of price. Therefore, a water provision unit will be more efficient the lower the revenues for a given level of outputs.

### Physical outputs

In order to compare water provision units' performances, we use the three traditional physical outputs used in the literature: billed water in cubic meters, number of customers and the pipes' length in kilometers. These three variables actually represent the three professions of water operators: producing and distributing water, managing customers' service and managing pipe maintenance.

Billed water is a conventional measure of the water production activity and is represented, in our database, by the total volume of water delivered and billed to households and non-households customers. We do not take into account exports neither in billed water nor in revenues.

The number of customers is also a commonly used output (see for instance Saal and Parker [2000] and Corton and Berg [2009]). The number of customers in our database also represents the number of properties connected for water supply. In French urban areas, a connection can represent a whole building or a part of the building. Several studies underline the relevance of combining both the volume of water billed and the number of customers

(Saal and Parker [2006], Corton and Berg [2009]). For instance, Saal and Parker [2006] justify this specification by the fact that the two tasks have different characteristics and heterogeneous marginal costs. Moreover, previous researches (Garcia and Thomas [2001]) have suggested that because of the cost of maintaining network connections, the number of customers is an important determinant of water industry costs and revenues. According to Erbetta and Cave [2007], this specification is a proxy for the scale of the distribution activity.

Furthermore, water suppliers may have different revenues depending on the length of mains (Corton and Berg [2009]). Therefore, as regards the outputs commonly used in benchmarking studies (see for instance Thanassoulis [2000a,b]), we add the length of mains as an output. Thanassoulis [2000a,b] argued the length of mains reflects the geographical dispersion of connections. For Berg and Lin [2008], this variable is an indicator of capital. We expect that the higher these explanatory variables, the higher the DMU's revenues.

#### Quality outputs

In addition to traditional measures of technical efficiency, service quality is a performance indicator that warrants attention, since one important characteristic of water companies is that they must comply with quality standards. To measure performance, we use a variable that gives us information about environmental performance and network quality. This quality indicator is an important outcome as private operators usually justify their higher prices by higher quality standards.

To measure network quality and environmental performance, we use the network performance measured as the ratio between billed water and the sum of billed water and water losses. Some studies use water losses to take account for deficiencies in either operational or commercial practices. Indeed, as argued by Corton and Berg [2009], water losses may reflect a cost trade off between increasing water production and repairing network leaks to keep up with water demand. Hence, the idea is that, to satisfy demand, managers may find it more costly to repair leaks and to control water losses than to increase water production. For Garcia and Thomas [2001], water network losses are considered as a non-desirable output produced jointly with the service of water delivery. For their part, Coelli et al. [2003] regard water losses as an indicator of the technical quality of service. Network performance is a good quality indicator for at least two reasons. First, dealing with leaks implies investments in leakage detection systems. Second, it is very costly in human capital. Leakages are repaired using human workforce.

One might argue that we could use some other variables to measure quality such as water quality or consumers' satisfaction for example. In some developing countries, service coverage, service continuity or the percentage of water receiving chemical treatment are adequate variables to measure water quality (see for instance Berg and Lin [2008] in the case of Peru and Corton and Berg [2009] for the Central American water utilities). In contrast, in developed countries where water services cover nearly all the population, alternative measures of quality are required (see for instance Saal and Parker [2000, 2001]).

Regarding drinking water quality, we could have retained compliance with microbiological standards measured as the percentage of successful tests (see for instance Saal and Parker [2000]). It is sometimes considered as an "environmental" advantage for the supplier, since the drinking quality is often regarded as being closely linked to the production of drinking water from groundwater (see for instance Bouscasse et al. [2008]). However, a higher quality of drinking water may also come from DMUs' efforts to achieve the qualitative criteria. In this case, a positive impact on revenues is expected. In our sample, the drinking water quality never exceeds the 5% of non-compliance and variance is less than 1% for the full-sample. Because of this low variance, we prefer to consider network performance rather than microbiological quality. In our opinion, it is a far stronger indicator to better understand differences in performance. In order to take into account the need for good water quality and its costs, we controled for some characteristics of water in the environmental variables.

### Environmental variables

The efficiency of a firm could be affected by exogenous conditions that are not under the direct control of managers. Environmental variables have been included because they may influence the technology under which water utilities operate and may account for exogenous differences in operating environments experienced by each firm (see Bhattacharyya et al. [1995] and Garcia and Thomas [2001] among others). These variables account for the different characteristics of networks and areas, thus controlling for heterogeneity among DMUs. The environmental variables used are consistent with many of the empirical studies mentioned.

We use five environmental variables that are common to the literature (see Erbetta and Cave [2007] for instance). The source of water is a proxy not only for the complexity of service provision, but also the level of specific investments needed to operate the service, an important variable from a transaction cost perspective (Williamson [1999]). Indeed, as noted before, a better quality of drinking water may be due to a higher share of groundwater sources for an operator. The source of water determines the type of treatment as the quality of underground water is generally more stable over time, reducing uncertainty about the evolution of the kind of treatment over the life of the contracts.

Moreover, we use two variables referring to water treatments. A dummy equals 1 if water treatment is complex and 0 either. A complex treatment is, according to the Health ministry, an A3-type treatment, i.e. an advanced physical and chemical treatment and a disinfection in several steps. Non-complex treatments such as A1 and A2 only include physical and chemical treatment plus a simple disinfection. We also account for the use of multiple or mixed treatments. Indeed, some utilities have multiple sources of water and thus need mixed treatments or to invest in particular factories. We thus insert a dummy that equals 1 if the treatment is mixed and 0 otherwise.

An extensive literature has included measures of the density of operations as an important determinant of water industry costs (see for instance Bhattacharyya et al. [1995] and Estache and Rossi [2002]). Therefore, the water service density or, in other words, the population density is included in our specification and is defined as the ratio between inhabitants served per kilometer of water main (i.e. the ratio between the population provided with water and the length of mains). For Erbetta and Cave [2007], providing service to a more concentrated population is, generally, cheaper than providing a dispersed population. The idea is the following: the higher the dispersion of the network, the more maintenance and energy are needed. However, as argued by Bottasso and Conti [2003], the population density may have ambiguous effects on cost inefficiency for two reasons. On the one hand, it may be more expensive to supply water to dispersed customers. On the other hand, a higher density may create congestion problems.

Some water services can be subject to a high volatility of demand due to seasonal variations in the population that might necessitate overcapacity in order to satisfy peak-load demand. This is the case of touristic areas that have higher demand during national holidays. A dummy variable for the touristic nature of the service takes the value 1 if the service area is considered to be touristic according to the *French National Institute for Economics and Statistics* (INSEE) classification and 0 otherwise.

Moreover, small towns have fewer internal resources either to produce water themselves or to pay external experts and to monitor and control private operators. At the same time, private operators have little incentive to operate in small towns. This may explain the tendency of small towns to create pools, which then provide water directly through a joint bureau of outsource. A dummy equals 1 if the municipality provides water jointly with other local authorities, 0 otherwise.

Descriptive statistics are presented in Table 3.1 such as to compare public and private management at the DMU-level. Table 3.1 is divided in two parts. The left part shows the descriptive statistics for public management and the right part shows descriptive statistics for private management. As we can see, private operators get on average higher revenues which is consistent with the fact that they have on average higher outputs, including higher network performance. The impact of the environmental performances on inefficiencies is not predetermined. However, we observe overall that private management is associated with higher density, interconnected networks and more complex treatment while public management is associated with ground water, mixed treatment and touristic areas.

Table 3.1: Descriptive Statistics: Public vs. Private Management

| | Public Management | | | | Private Management | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Mean | Standard deviation | Min | Max | Mean | Standard deviation | Min | Max |
| **Dependant variable** | | | | | | | | |
| *Revenues (in thousands)* | 6,183.944 | 7,407.255 | 773.149 | 37,220.44 | 9,027.477 | 37,624.75 | 889 | 407,840.4 |
| **Physical outputs** | | | | | | | | |
| *Volume billed (in thousands)* | 5,095.302 | 5,982.645 | 830.6 | 29,556.4 | 5,999.989 | 22,928.11 | 681.358 | 248,223 |
| *Length of mains* | 476.1578 | 511.4282 | 65.89 | 3,094 | 559.546 | 1,541.276 | 29.64 | 14,157 |
| *Customers* | 25,980.1 | 28,100.24 | 3,378 | 176,500 | 26,475.63 | 61,359.26 | 1,409 | 547,938 |
| **Quality Output** | | | | | | | | |
| *Network Performance* | 0.751 | 0.094 | 0.506 | 0.923 | 0.778 | 0.093 | 0.345 | 0.939 |
| **Environmental variables** | | | | | | | | |
| *Population density* | 196.9848 | 114.6751 | 67.8112 | 791.667 | 218.1504 | 128.4048 | 31.725 | 717.329 |
| *Touristic Area* | 0.157 | 0.367 | 0 | 1 | 0.091 | 0.289 | 0 | 1 |
| *Ground Water* | 0.294 | 0.460 | 0 | 1 | 0.248 | 0.433 | 0 | 1 |
| *Interconnected* | 0.412 | 0.497 | 0 | 1 | 0.430 | 0.497 | 0 | 1 |
| *Mixed Treatment* | 0.353 | 0.483 | 0 | 1 | 0.306 | 0.463 | 0 | 1 |
| *Complex Treatment* | 0.392 | 0.493 | 0 | 1 | 0.570 | 0.497 | 0 | 1 |

### Representativeness

In order to ensure the validity of our results for the whole French main water utilities, we need to compare the dataset of this paper regarding the main dataset on French water utilities - the IFEN-SOeS dataset. IFEN-SOeS is a nationally representative dataset of water utilities in France that has been collected four times (1998, 2001, 2004 and 2008) and contains a range of information on water demand and supply. As IFEN-SOeS stops in 2008 while OSEA is collected for 2009, the comparison will especially be on the efficiency difference between the two organizational choice. Table 3.2 shows the distribution of public and private management in IFEN-SOeS and OSEA and the difference in prices for a standard bill (i.e. a bill for a household of three persons). As we have no data on revenues or costs in IFEN-SOeS, we picked prices as a proxy for revenues. Revenues are indeed highly correlated to consumption and connection to the network. OSEA over-represents directly managed utilities but gaps between public and private efficiency, measured by price, remain the same. In the two datasets, we observe a 20% gap between public and private management in terms of price. Overall, we conclude that our dataset is representative of the DMUs serving more than 15,000 inhabitants.

Table 3.2: Comparison of IFEN-SOeS with OSEA

| | **IFEN Dataset** | | |
|---|---|---|---|
| Variable | Public Management | Private Management | Mean |
| *Share* | 22% | 78% | - |
| *Price of the 120 cubic meters bill* | 140.88 | 176.41 | 170.29 |
| *Observations* | 137 | 479 | - |
| | **OSEA Dataset** | | |
| *Share* | 30.5% | 69.5% | - |
| *Price of the 120 cubic meters bill* | 141.83 | 174.12 | 164.21 |
| *Observations* | 54 | 123 | - |

We also look at the representativeness of the dataset in terms of its covering rate of the national population, customers or billed water. Despite missing data concerning big French cities such as Lille, Lyon, Paris and Toulouse, our dataset covers 17.5 million inhabitants, 4.5 million customers and more than a billion of cubic meters billed. We thus have utilities that represent 30% of the population and a quarter of total water consumption in France. In the next three sections, we describe the variables used to assess efficiency.

## 3.6 Empirical Results

### First-Stage Results

A summary of the first-stage results of our model is presented in Table 3.3. Table 3.3 details efficiency scores for public and private management and for the full-sample. It also reports the number and the share between parentheses of efficient DMUs. The last two lines report the mean input slacks and its standard deviation. The mean technical efficiency score equals 0.754 which indicates that the average company could become efficient by reducing its revenues by almost 25%, still producing the same amount of outputs. Public management has an efficiency score of 0.825 while private management has an efficiency score of 0.724. The minimum value is 0.373 for private management and 0.450 for public management, indicating that there are substantial differences among water services. We computed a ranking using the efficiency score, the number of times an observation appears during the construction of the DEA frontier and its cumulative weight in the construction of the frontier[43]. Even if private management is less efficient on average, it provides a larger stock of DMUs for the construction of the frontier. It has thus a larger impact in absolute value but it is relatively less performing than public management. For the full sample, 18% of DMUs are efficient but 23.53% of publicly managed utilities and 15.70% of private utilities.

[43]Rankings are not published in the thesis for confidentiality reasons.

We finally report the input slacks and its standard deviation. As we expect regarding the efficiency score, private managers have to endorse larger revenue cuts than public managers to be efficient. These input slacks will be used to re-adjust inputs for the final stage.

Table 3.3: Public vs. Private Management - 1st Stage

| | **Public Management** | **Private Management** | **Full Sample** |
|---|---|---|---|
| | Score | Score | Score |
| Mean | 0.825 | 0.724 | 0.754 |
| Standard Deviation | 0.144 | 0.188 | 0.182 |
| Min | 0.450 | 0.373 | 0.373 |
| Max | 1 | 1 | 1 |
| Best Rank | 3 | 1 | - |
| Efficient DMUs | 12 (23.53%) | 19 (15.70%) | 31(18.00%) |
| Observations | 51 | 121 | 172 |
| Input Slacks | 873.256 | 1293.377 | 1168.806 |
| Standard Deviation | 1351.338 | 1659.967 | 1582.612 |

### Second-Stage: SFA and Input Adjustment

Table 3.4 summarizes the first step of the second-stage which consists in a SFA regression of inputs versus the environmental variables. Results suggest that the operating environment does exert a statistically significant influence on water supply performance. As we can see, the coefficients are all positive and mostly significant. To better understand the results, it is easier to start with an example. Ground water has a positive and significant impact on input slacks, meaning that it has a significant negative impact on efficiency. Being localized in a touristic area, complex and mixed treatments, population density and interconnected utilities all have a positive impact on inputs slacks, i.e. on inefficiencies, and thus a negative impact on efficiency.

Results in Table 3.4 also shed light on the contribution of statistical noise to DMUs' performance. The $\gamma$ is computed as the ratio between $\sigma_{u^2}$ and $(\sigma_{v^2} + \sigma_{u^2})$. $\gamma$ lies between 0 and 1. The closer it is to 1, the less statistical

Table 3.4: Second Stage: Input Slacks versus Environmental Variables

| **Variables** | Input Slacks |
|---|---|
| Ground Water (=1) | 286.238*** |
| | (25.353) |
| Touristic Area (=1) | 192.449*** |
| | (42.449) |
| Mixed Treatment (=1) | 291.899*** |
| | (53.388) |
| Complex Treatment (=1) | 17.763 |
| | (65.637) |
| Population density | 1.460*** |
| | (0.068) |
| Interconnected (=1) | 233.831** |
| | (112.929) |
| Constant | -1299.06*** |
| | (104.757) |
| $\gamma$ | 0.999 |
| Log-Likelihood | -1452.255 |

Standard errors in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

noise there is in the model. As $\gamma$ tends to 1, statistical noise is very low in our model. This suggests that the environmental variables explain virtually all of the variation in input slacks.

In a second step of this second-stage, we use the results from the SFA to adjust the input following Fried et al. [2002] described above. As a result, we will put all the DMUs in the worst production environment by correcting the input upward.

### Third-Stage Results

Table 3.5 summarizes the differences in performance results between public and private water companies after having adjusted the input. The table shows the results separately for public and private management. The mean technical efficiency score equals 0.841 versus 0.754 in the first-stage. The average correction is thus 0.087. This supports that some DMUs that received relatively low initial performance evaluations did indeed have a valid complaint, due to their relatively unfavorable operating environments or their relatively unfavorable extenuating circumstances. DMUs under public management are adjusted upward by 0.059 while DMUs under private management are adjusted upward by 0.100. Private management is thus not as poorly managed as the first-stage indicated. The minimum is adjusted upward also from 0.373 to 0.496. Accounting for different operational environments is thus helpful to correct for efficiency. Overall, we now have 30 efficient DMUs against 31 in the first-step. Some DMUs were unfairly considered as being efficient in the first-step while some others were unfairly considered inefficient. There is thus an efficiency gap of 6% between public and private management in the French water supply industries.

However, the Spearman correlation test of the first and the third steps equals 0.890 and is significant at the 5% threshold. The Kendall correlation test - which depends upon the number of inversions of pairs of objects which would be needed to transform one rank order into the other - is 0.700. These tests indicate that results from the first and third steps are highly correlated. It also means that DMUs that received relatively high (low) initial performance evaluations did so in relatively favorable (unfavorable) operating environments and circumstances. Accounting for contextual variables renders the results more robust but does not fundamentally change the relative DMUs' managerial performance.

Graph 3.2 depicts the link between billed water and technical efficiency by organizational form. As we can see, there is no clear link between the size of the market and technical efficiency, whatever the management type. For easiness in reading, we excluded utilities billing more than 40,000 thousand

Table 3.5: Private vs. Public management - Final Results

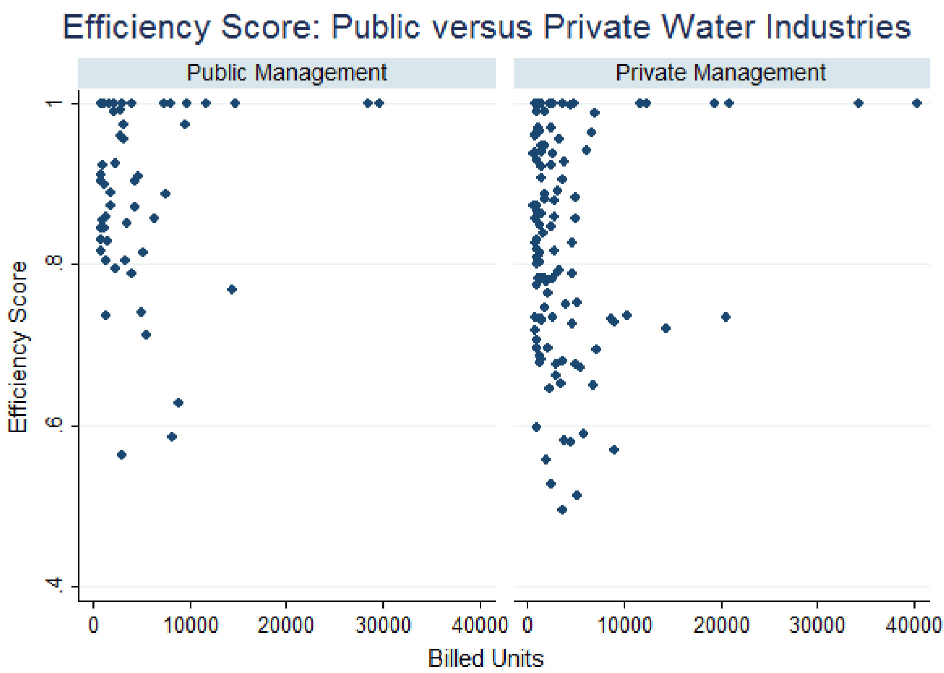
| | **Public Management** | **Private Management** | **Full Sample** |
|---|---|---|---|
| | Score | Score | Score |
| Mean | 0.883 | 0.823 | 0.841 |
| Standard Deviation | 0.112 | 0.132 | 0.129 |
| Min | 0.564 | 0.496 | 0.496 |
| Max | 1 | 1 | 1 |
| Best Rank | 1 | 3 | - |
| Efficient DMUs | 13 (25.49%) | 17 (14.05%) | 30(17.44%) |
| Observations | 51 | 121 | 172 |
| Average Correction | 0.059 | 0.100 | 0.087 |

cubic meters in 2009 (a single utility - which was moreover efficient - has been dropped). However, we notice a greater level of dispersion of technical efficiency for private management.

Our ranking method follows a simple rule (see Fried et al. [2002]). We rank DMUs regarding i) their efficiency scores, ii) the number of times they are used as references for defining the frontier and iii) the cumulative sum of their weight in defining other DMUs' scores. A lot of utilities are close to the efficiency frontier as 66 DMUs have efficiency scores larger than 0.9. While private operators are under-represented in the efficient DMUs, they are largely represented in the less efficient DMUs. For example, if we only consider utilities with efficiency scores below 0.7, we find that 23 out of 26 DMUs are under private management. The average efficiency gap between public and private management results from this higher dispersion of utilities' efficiency score.

Such a dispersion in privately managed utilities can be explained by several factors. First, private operators can have differentiated strategy depending on some structural aspects of the municipality. Moreover, municipalities themselves may have different capabilities in negotiating contracts before and after the bidding process. Differences in performance can thus appear as differences

Figure 3.2: Technical Efficiency and Size of the market




in transaction costs resulting from different capabilities.

## 3.7 Extension Using Econometrics

As a robustness check of our ranking, we ran a simple econometric model linking net revenues with the characteristics of the utilities. Using the coefficients of the model, we then predict what would be the optimal level of revenues, regarding the mean of the sample. We expect results to differ overall as Ordinary Least Squares (OLS) benchmarks utilities regarding the mean of the sample while DEA benchmarks utilities regarding the most efficient utilities. However, this robustness check is useful if we can find similarities with the DEA result.

In order to evaluate DMUs efficiency using econometrics, we run the following OLS model:

$$NR_i = \alpha_0 + \vartheta X_i + \varepsilon_i \tag{3.5}$$

with $NR_i$ the net revenues for utility $i$, $\alpha_0$ the constant, $\vartheta X_i$ a vector of variables influencing net revenues and $\varepsilon_i$ the error term. As several other studies on the cost structure of regulated utilities (see for example Garcia and Thomas [2001]) we assume that returns are decreasing. Results are reported in Table 3.6. As expected the R-squared is close to one as net revenues depend on billed water, customers and the length of the networks. We also included the contextual variables that can be significant at explaining differences in revenues. However, we do not find a significant coefficient for network performance, probably meaning that a part of network performance can be funded by billed volumes, customers and pipes' length. Using the results described in table 3.6, we can assess performance measured as the closeness to the prediction. Our "efficiency measure" will be then computed as:

$$Performance_i = \frac{\widehat{NR_i} - NR_i}{NR_i} \tag{3.6}$$

with $\widehat{NR_i}$ the estimated net revenues using equation 3.5. Equation 3.6 computes performance as the distance in percentage to the practice set by the model. In this case, DMUs performing well will have a positive performance index while DMUs performing poorly will have a negative performance index.

The Spearman test of the ranking of the third-stage DEA and the present ranking gives a correlation of 0.6806 at the 5% threshold. It shows that both ranking are quite close overall. However, the Kendall's correlation score is 0.4994, meaning that there are numerous inversions. However, the managerial performance is overall the same as in the DEA-ranking. We can conclude overall to a consistent ranking even using econometric methods.

Table 3.6: OLS Regression

| VARIABLES | (1)<br>Net Revenues |
|---|---|
| Billed Units | 0.542*** |
| | (0.0890) |
| Customers | 0.0344 |
| | (0.0609) |
| Pipes' Length | 0.430*** |
| | (0.101) |
| Network Performance | 0.256 |
| | (0.181) |
| Network Density | 0.371*** |
| | (0.0965) |
| Ground Water (=1) | 0.0988** |
| | (0.0435) |
| Mixed Water (=1) | 0.0725 |
| | (0.0453) |
| Interconnected (=1) | 0.0185 |
| | (0.0539) |
| Touristic Area (=1) | 0.0366 |
| | (0.0780) |
| Treatment FE | Yes |
| Constant | -2.002** |
| | (0.820) |
| Observations | 172 |
| R-squared | 0.949 |

Note: Robust Standard Errors in Parentheses with *** p<0.01, ** p<0.05, * p<0.1.

## 3.8 Conclusion

This article provides an efficiency analysis of 172 French water utilities for 2009. In order to dissociate managerial efficiencies from bad luck and structural differences across utilities, we employed an outliers detection and a three-stage DEA approach. While the first-stage DEA would conclude on a large advantage of public management, leveling the playing field leads to lower differences in efficiency between public and private management. The remaining differences can be divided between managerial inefficiencies, higher margins or differences in taxation. Overall, we found large differences in efficiency from a DMU to another, leaving room for potential cost savings or price decreases.

The first-stage DEA gives an average technical efficiency score of 0.754 with the lowest score at 0.373. After controlling for contextual variables and statistical noise, technical efficiency scores range from 0.496 to 1 with an average of 0.841. Public management scores on average 0.883 while private management scores 0.823 in the last stage while the gap was 10% in the first-stage.

We can discuss the results regarding some missing information about public and private management. A study by the Boston Consulting Group [2007] for example shows that private management faces higher costs than public management because of differences in tax-burdens. As a matter of fact, the cost of labor is higher under private management and private DMUs have to pay several local taxes. This can lead to a 9.5% fiscal overload charged to the private DMUs. Such an overload, regarding our previous results of a 6% gap means that private firms are, everything else being equal, more cost-efficient or operate with lower margins, a result that is discussed in Porcher [2012b]. Another explanation for this 6% efficiency gap lies in the water budget debt difference between public and private management.

Because of missing information, we were able to collect water budget debt for only 117 DMUs, 52 under public management and 65 under private management. However, a simple means comparison is useful to understand the technical efficiency gap between public and private management. For utilities that provide water in-house, the water budget debt is 7,211,440 euros while it is 5,812,337 euros in municipalities under private management. There are at least two reasons for this gap between public and private management. The first reason is that private managers fund a part of their investments through the price setting while public managers may directly use the municipal water debt. As a result, water budget debt is expected to be lower under private management. The second reason is that debt refunding is partly linked to the life-cycle of the contract as shared investment programs are launched for a given number of years. One can expect a municipality to engage in a faster debt refunding when the water supply is contracted out, perhaps because its refunding rates follow the duration of the investment program, itself anchored on the duration of the contract. Assume that directly managed DMUs had to converge to the level of debt of privately managed DMUs, then we could expect that directly managed utilities would increase their revenues everything else being equal. Such an increase would lead on average to lower technical efficiency of public management regarding private management. Future research could focus on the importance of public finance.

The broader conclusion of the paper is that we need more research based on real data to achieve better regulation of water supply. Future research could for example focus on other exogenous factors, the use of panel data and broader datasets. This article supports regulatory policies and contract evaluation based upon real-data and benchmarking analyses.

Chapter 4

# Efficiency and Equity in Two-Part Tariffs: The Case of Residential Water Rates*

## 4.1 Introduction

In regulated markets such as energy, electricity, water and wired phone service, where price schedules can have strong distributional consequences and economic distortions, it is crucial that pricing appropriately encourages equity and efficiency in use. This historical debate has given way to a rich theoretical literature examining utility pricing in relation to the public interest. Hotelling [1938] first argues that all prices in an economy should be set equal to marginal cost, with fixed costs paid for with government subsidies from income, inheritance and land taxes. Coase [1946] considered that efficient pricing in regulated markets implies two-part tariffs. Further theoretical developments usually consider a Ramsey-Boiteux pricing to derive how prices should be marked up above marginal cost (Baumol and Bradford [1970]) in order to meet the social revenue requirement. Equity is first incorporated into

*This chapter is derived from an ongoing working paper. We thank Dakshina da Silva, Philippe Gagnepain, Stéphane Saussier and Alban Thomas for their comments on the paper as well as participants of the Congress of the Association Française de Sciences Economiques, July 2nd-4th, 2012.

the efficiency analysis by Feldstein [1972] who assumes a functional form of the social welfare function and derives formulas for the socially optimal two-part tariff. These Ramsey-Boiteux pricing schemes however represent second-best optima as they suppose deviations from marginal cost pricing. The challenge in regulating markets is that price be set such as to enforce efficiency and equity.

Water supply exemplifies this issue. Water is a large market that directly affects over 99% of French households. The French water market - including water provision and sewerage - represented a market of 5.4 billions euros in 2008. The same year, 4 billions cubic meters of water have been billed to domestic users and industrial consumers. The main costs for water provision can be divided in three parts. First, water provision implies costs for extracting, treating and distributing water to the consumer. Once water enters the network, around 10% is lost in leakages. In addition to these costs, water utilities face the relatively fixed costs of processing bills and taking calls. Moreover, water utilities have to maintain networks and connections and install water meters. The scale of the costs thus differ from one utility to another: the costs of production depend on the volumetric charge while the scale of the fixed costs is largely invariant to the number of customers, such as customer service or meters management, or to the size of the network, such as maintenance.

In France, regulation is made through a contract between a private operator and the municipality when the public service is outsourced and through a public council decision when the public service is managed in-house. As a result, local monopolies are largely unregulated: they tend to maximize profit by pricing above marginal cost, resulting in a level of output below the socially optimal level. As in many regulated industries, in the simplest case, the tariff for consumers is divided in two parts: a fixed fee, no matter the level of consumption, and a volumetric charge depending on water consumption. A standard result first developed by Coase [1946] is that setting marginal prices to marginal costs would eliminate the deadweight loss associated with monopolies. The local monopoly then recoups its fixed costs through fixed fees equal to each customer's share of fixed costs.

Although it is compulsory to use two-part tariffs in the French water sector, operators tend to charge fixed fees and volumetric charge that differ from the theoretical ideal. This paper applies the standard monopoly framework to answer the following questions: (1) How much marginal prices differ from marginal costs? (2) What are the distributional impacts of a switch from current tariffs to Coasian tariffs? (3) Do the Coasian tariffs fit better the equity considerations? (4) What are the efficiency costs from the observed deviations from marginal cost pricing?

This paper examines a nationally representative dataset of 4,500 French municipalities for 2008. The dataset contains demographic and economic information about households at the municipal level, but also a large set of information on water demand and supply, such as consumption, spendings, rates and some water utilities characteristics. We find that marginal prices differ from marginal costs. Even if the range of the deviation is limited - a 8% deviation is observed for the volumetric charge - these markups impose a deadweight loss by leading customers to consume too little water and to support fees that do not represent capital costs. Rebalancing rates to match the Coasian tariffs imply large increase in welfare for consumers, especially those living in cities with lower incomes. This is due to the fact that the correlation between water consumption and income is significantly positive but flat. Consequently, reformed price tariffs benefit more to households consuming a lot of water more than households with low incomes. As a matter of fact, after the transition to Coasian tariffs, cities in the first fourth quintiles regarding the per-unit income would experience decreases in bills that are almost similar, between 21.45 and 20.07 euros per year. We thus consider alternative water assistance programs focusing directly on cities with lower per-unit incomes. We particularly find that a free fixed fee policy could be implemented for poor cities, without loss of profits for firms, at the cost of 1.90 euros per non recipient.

We then compare the costs of these assistance policies to the current efficiency costs. Under conservative levels of price elasticities, a transition to marginal cost pricing implies efficiency gains of 8 million in 2008, a level that is low compared to the global profits of water industries in France[44]. However, these efficiency gains are sufficient to fund assistance programs such as decreased fixed fees for poor households.

The paper finally highlights several explanations for the current price distortion, such as firms' profit maximization (small versus large consumers?), resource scarcity (markup versus Pigouvian taxes?) and management structure (public versus private?). We then briefly discuss the validity of the results, precisely regarding consumers' responses to marginal prices and the link with related markets, such as sanitation.

The paper contributes to the literature on public utility regulation in several ways. First, it shows that contrary to other regulated industries, water supply in France has low-margins. However, deviations from marginal cost can have strong welfare and distributional impacts. Second, several assistance

[44] These are national estimations and profits include industrial and residential consumption. At the scale of our dataset, the deadweight loss from current tariffs for residential customers is 5.36 million euros for 2008 and the global profits of water industries for residential customers are 3 billion euros.

policies are empirically tested and the study shows that at low-cost for water suppliers, it is possible to fund some assistance programs. These assistance programs have stronger distributional consequences than tariff reforms. The results of the paper are similar to those of Garcia and Reynaud [2003] who estimated the benefits of efficient water pricing in France using a sample of 50 water utilities for four years. Even if the authors found that marginal prices were on average lower than marginal costs while fixed fee were marked up above each customer' share of fixed costs, they find a low-price elasticity as in this paper, resulting in rather small welfare gains of efficient pricing. However, they conclude on the positive impact of rebalancing rates under some social objectives. In this paper, we complement this approach by simulating the impact of some social policies.

The paper proceeds as follows. Section 2 presents relevant background information about the organization and the regulation of the French water market. Section 3 describes the two datasets, their validity and performs a test of marginal cost pricing. Section 4 examines the distributional consequences of a transition to Coasian tariffs when demand elasticity is null. Section 5 performs an estimation of price elasticities, computes the efficiency effects of marginal cost pricing and examines the reasons for current markups. Section 6 discusses the results. A brief conclusion follows.

## 4.2 The French Water Market

### Organization and Regulation

In France, as in most European countries, municipalities must provide local public services that have public good characteristics. Water provision and sewage are two of these public services and can be managed by two different operators[45]. However, if the responsibility for public services' provision is public, its management can be either public or private. Although some municipalities manage production through direct public management and undertake all operations and investments needed for the provision of the service, the dominating contractual form is delegated management[46]. In this case, a private operator, independent of the local government, is hired to manage the service and operate facilities, through one of the four different private-public arrangements. The most common is the *lease* contract in which the operator manages the service, invests in the network and gets a financial compensation through consumer receipts. Under a *concession contract*, the external operator also undertakes construction risks, as it must finance a large part of investments over the duration of the contract. These contractual agreements differ from the previous ones in that operators share risk in exchange for greater decision rights and claims on revenues. Other contracts can be chosen by the local authority such as the *gerance* in which it pays an external operator a fixed fee, or an *intermediary management contract*, i.e. a gerance contract but with a small part of the operator's revenues depending on its performance. Such contracts provide few incentives to reduce costs and transfer no risks and decision rights to a private operator. Although there are a large variety of contracts, the participation of the private sector is characterized by a concentration on three major companies. These companies share with their subsidies more than 90% of the private market and other private companies operate mainly in small cities.

[45] *Water provision* refers to the production and the distribution of water and *sewage* implies wastewater collection and treatment. We focus in this paper on water provision.

[46] An official report by Dexia, a French financial intermediary, states that 63% of French medium-sized cities contract out the services of drinking water treatment and distribution and 58% also contract out their sewerage services. It is however difficult to have a precise estimation of how many municipalities and communities have contracted out both services with the same operator. In our database, more than 60% of the municipalities are managed by private operators. According to the Cour des Comptes [2011], the highest financial court in France, 71% of the population is covered by a private operator for water provision and 56% for water sewage.

Contrary to other industrialized countries, there is no price-cap or rate-of-return regulation for water utilities in France as there is no national regulator. Such regulation has been replaced by a contract, in the case of a private operator, or a decision of the municipality board, in the case of public operation. In the case of delegated management, rules have been defined to ensure that standards are respected during the operation to limit the opportunistic behavior of operators and guarantee competition between firms. First, since the Sapin Law (1993) a national legislative framework governs the form of the private sector participation and the conduct of the bidding process. Second, a strong regulation on contract duration and delegatee obligations was implemented in 1995 with the Barnier Law. As a matter of fact, water quality in France has increased and is now relevant for more than 99% of the tests and a lot of investments have been implemented to deter leaks. However, because regulation is made through contracts between the two parties, depending on the respective power of negotiators, with some contracts signed a century ago, there are doubts about the possibility of the parties to regularly adapt tariffs to the needs of the utilities. Even if they did, water tariffs may not be efficient nor equitable from the economic point of view.

### Tariffs

Applying an efficient tariff for water is difficult to achieve. To be efficient, the design of the tariff must satisfy several conditions. The main objective of the pricing scheme is to generate revenues covering costs. However, the pricing rate should also allow different costs between users with heterogeneous financial means as much as it has to provide incentives for efficient use of the resource. As these criteria may be contradictory, finding a rate structure balancing efficiency and equity is not an easy task.

Previous studies on efficient pricing focused on which price schedule yields the highest level of utility, using the framework of the second-best pricing, the so-called “Ramsey-Boiteux” pricing. When searching for utility maximization under linear prices solved by Ramsey [1947], Boiteux [1956] shows that the welfare-maximizing price markup is proportional to the inverse of the elasticity of demand. “Ramsey-Boiteux” pricing ensures the welfare maximization under a budget constraint. In this framework, a monopolist facing inverse demand function $p_i(x_i)$ for good $i$, a social planner constrained to using linear prices can maximize social surplus by setting prices

$$\frac{p_i - \frac{\partial C(X)}{\partial x_i}}{p_i} = -\left(\frac{\partial p_i x_i}{\partial x_i p_i}\right)\left(\frac{\lambda}{1+\lambda}\right) \tag{4.1}$$

where $\lambda$ is a non-negative constant. Such a framework is for example used by Garcia and Reynaud [2003] to reform French water tariffs but also by Diakité et al. [2009] to implement social pricing in Côte d’Ivoire. However, this optimal solution implies that the utility knows demand-elasticities for each consumer and that regulators or parties to the contract constrain themselves to linear prices. In practice, network industries such as water but also electricity or gas have long implemented two-part tariffs. Water tariffs in France have two compulsory components since 1994. On the one hand, each customer must pay a fixed charge corresponding to provisions for capital stock renewal and debt service. On the other hand, a marginal tariff corresponds to operating expenses of the volumetric charge. For a baseline annual household water consumption of 120 cubic meters, the fixed-part of the tariff represents 25% of the total price. Moreover, there are additional fees going to the Basin Agency and a value-added tax for the State.

A standard result in regulation is that efficiency requires marginal prices to equal marginal costs. In the water industries, the obligation to have a two-part tariff facilitates pricing at marginal cost because the volumetric charge can be set equal to marginal cost and the fixed monthly fee set to cover fixed costs. Pricing at marginal cost may have many drawbacks. Indeed, it is inappropriate when managers have no budget constraints as they would have no incentive to reduce costs. Moreover, marginal cost pricing implies that the utility runs a deficit if there are increasing returns to scale. This deficit might lead to distortionary taxes if there are no lump-sum transfers. As first suggested by Coase [1946], an alternative solution to marginal cost pricing is to use two-part tariffs with a marginal price corresponding to the marginal cost and the fixed fee set to cover the total fixed costs. In water industries with declining average costs and constant marginal costs[47], this would imply setting the fixed monthly fee equal to each customer's share of the utilities' fixed costs.

Efficient pricing may however not be achieved in water industries for two reasons. On the one hand, water utilities face volatile revenues. For example, water consumption is often higher during summers than winters while some touristic areas face high consumption levels during national vacations. Over the years, billed volume of water tend also to decrease, probably due to changing consumer behavior towards sustainable water use and to less consuming intermediary goods. This revenue volatility is a source of concern for water utilities. On the other hand, operators and city councils set tariffs such as the expected revenues from water sales covering the forecasted expenses, which is close to an average-cost pricing. In practice, water tariffs thus differ from the theoretical ideal of marginal cost pricing.

There are at least two reasons why marginal cost pricing has not been implemented. The first one comes from the diminished profits that would oc-

[47]Because of the fixed tariff, average costs are declining with consumption. Marginal costs are supposed here to be constant as scale effects used in alternative regressions are very weak. Discussions with professionals let us know that marginal cost depends first of all on the age of the plant more than on the volumetric charge.

cur for the water industries if fixed fees remain the same. The second one lies in the distributional implications of such a reform. Such a decrease in marginal prices would especially benefit households consuming a lot of water rather than households consuming little water. To the extent that income and water consumption are related[48], this would mean that higher incomes would face larger decrease in their bills than lower incomes would.

One might argue that water tariffs already include distributional considerations because rates can include non-linear pricing schemes. These pricing schemes aim at taking into account resource sustainability and distributional considerations. In our dataset, 1,260 municipalities have non-linear tariff schemes. Even if we have little details about the tiers - we know the kink points at which consumers switch from one tier to another - we observe only 152 municipalities with a two-tier tariff limitation below 300 cubic meters, which is higher than the average consumption of the top 10% residential consumers. Most of the multi-tier tariff schemes thus benefit huge consumers such as industries, public administrations and agricultural holdings.

### Water-poor in France

In France, 13.5% of French households have an income lower than 60% of the median income. For the lowest 10% incomes, the share of constraint households' expenditures has risen from 24% to 48% between 1979 and 2005 (Mareuge and Ruiz [2008]). Water affordability and access has been a hot topic in France as the French Parliament has been voting the right for an existing governmental agency to pay a part of the bill of households with financial difficulties, e.g. experiencing overindebtedness or unsanitary housing. While access to water is a recognized right in international conventions, public

[48] This assumption is tested below. The result is a significant positive but weak correlation between income and water consumption.

and private operators jointly created in 2000 a special fund to subsidize poor households which could not pay for their water bills. There are however very few statistics about water poverty in France. According to Smets [2004], there are 3 million French people experiencing difficulties to pay their water, electricity, gas or phone bills. The same year, over 700,000 households have asked to reschedule their water bills.

Defining water poverty is difficult as the threshold depends on local conditions. This is especially true for the French case where prices and incomes differ from one municipality to another. According to Smets [2004], the affordability index for households with an income below 40% of the median income varies from 2.5 to 3.5% in developed countries. A threshold of 3% was also proposed by the OECD and by the United Nations specifically for France (Reynaud [2007])[49]. Using this definition, Reynaud [2008] finds that 4.31% of French households are water-poor in 2006. As we only consider the first part of the bill representing exactly 50% of the whole tariff with value-added taxes, we consider water-poor as households paying more than 1.5% of their income in their water bill. Using this definition, there are 479,974 out of 16.5 million households in our dataset potentially experience water poverty. On average in our database, French households pay water provision bills lower than 0.7% of their income, a figure that is consistent with the UNRISD report by Reynaud [2007][50].

This definition of poverty is however limited. First, “water-poor” may not be household facing financial stress. A simple example can illustrate the

[49] Several studies such as Fitch and Price [2002] for the UK and Reynaud [2008] for France conclude that water poverty means that the share of income spent by households for water services is equal or higher than 3% for the three lowest deciles. They however consider a bill including water provision and sewage. Hence, being water-poor can result from one decision for the highest deciles.

[50] According to a report by Reynaud [2007] for the UNRISD, the average percentage of income spent on paying water charges is 1.20% in 2001 for French households.

limits of the definition. Households with swimming-pools can consume large amount of water resulting in consistent water bills. Second, from one consumer behavior perspective, water consumption may only be the result of utility-maximizing behaviors. For these reasons, we will use a broader definition of poverty and needs-based on the national poverty threshold.

## 4.3 Data and Research Design

We developed a unique dataset by combining data from the French Environment Institute (IFEN-SOeS), the French Health Minister (DGS) and the French National Institute for Economics and Statistics (INSEE) on 5,215 representative municipalities in 2008. Because of missing data, our results are extracted from a 4,500 observations dataset. We match this large dataset with a sub-sample of 650 observations on net results in the water industries for 2009. The unit of observation is a municipality.

### IFEN-SOeS database

The IFEN-SOeS, collected by the French Environment Institute and the Environment Minister, is a nationally-representative municipal survey of the public service of water. This sample is representative of the total French population and the local public authorities where they are living: all sizes of local authorities are proportionally represented and municipalities with more than 5000 inhabitants are all included. The IFEN-SOeS database provides detailed information about public water services and municipalities' characteristics. There has been four data collections in the last ten years. Data collection proceeded as follows. Municipalities fulfilled the database, then data was checked by the Environment Minister. The IFEN-SOeS is the only national representative dataset on public water services.

The database includes a lot of information at the municipal level about water consumption by domestic customers[51] and municipalities' characteristics that can influence water consumption. We know for example whether the city is located in a touristic area or not or in which region the city is located. The latest variables are important controls when one tries to explain water consumption: on the one hand, touristic areas face larger levels of consumption during some periods of the year; on the other hand, water consumption is higher in some regions such as the south of France. Moreover, we can create dummies to take into account the density of water consumption on the network. Using regulatory indicators provided by the French Observatory of Water and Aquatic Environments (ONEMA in French), we consider a city to be rural if the ratio of billed water and the length of mains is smaller than 10 and to be urban if this ratio is larger than 30. Cities with a ratio between 10 and 30 are considered semi-urban. These dummies provide helpful controls to normalize consumption levels from one municipality to another.

Table (4.1) reports covariate means and standard deviation by consumption-unit household income quintile. The first quintile for example includes cities in which the median income is between 0 and 159%. Annual per consumption-unit median income increases from an average of 14,275 euros in the first quintile to an average of 23,755 euros in the fifth quintile. Panel (A) in Table (4.1) shows some cities economic and demographic characteristics such as its touristic and urban status. Mean annual consumption and expenditure are relatively stable from one quintile to another in Panel (B). Mean annual consumption goes from 136.145 cubic meters per year in the first quintile to 139.541 in the fifth quintile for a relatively close expenditure. Marginal prices

[51]Domestic customers include households but also small firms and agricultural firms. In some cases, big firms are also included in domestic customers. We however do not take into account exports and a part of billed water sold to non-domestic customers, usually big firms with a particular tariff rate.

are similar in the quintiles 1 to 4 but very different in the fifth quintile where they are 7 to 10 cents more expensive. This difference in marginal prices is fulfilled by lower fixed fees in the fifth quintile. Cities with higher incomes face fixed fees equal on average to 38.611 euros while the first and second quintiles respectively pay 48.93 and 49.456 euros for their fixed fees.

Panel (C) describes water utilities characteristics that are useful to understand the differences in prices or costs of water production and distribution. On the one hand, ground water is usually associated with higher treatment complexity because it is more polluted than underground water. On the other hand, underground water is more costly to extract. Its impact on costs is thus not clear. Treatment complexity has a direct impact on costs and thus on the price of water. As Table (4.1) shows, higher quintiles are associated with higher complexity and lower underground water that explains the differences in marginal prices.

An important feature of the IFEN-SOeS dataset is that, in addition to characteristics about the contract such as ownership structure, it provides high-quality information about water bill structure. Even if we have little information about differentiated rates, we have a lot of information about the composition of a baseline bill for a household, defined by the National French Statistics Institute as a consumption of 120 cubic meters a year per household. At the baseline consumption level, we know the amount of the fixed-part and we can compute the marginal price per unit. As there are different rate schemes, one might consider that observed marginal prices do not fit non-linear pricing schemes. Table (4.2) shows the result of our test for consumption split in different tiers of the marginal tariff rate. For all the municipalities with multi-tier marginal tariffs, we reject the null hypothesis $H_0$ of an average consumption higher than the second-tier break even point with a $p$-value less than

Table 4.1: Descriptive Statistics by Per-Unit Adjusted Income Quintiles

| Percent of Poverty-Line | **<159%** | | **160-173%** | | **173-187%** | | **187-211%** | | **>211%** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **A. Cities Economic and Demographic Characteristics** | | | | | | | | | | |
| Mean Annual Median Income | 14274.95 | (1152.104) | 16252.64 | (401.4486) | 17639.02 | (407.7273) | 19401.02 | (672.9867) | 23754.71 | 3338.452 |
| Number of Household Members | 2.401 | (0.256) | 2.347 | (0.219) | 2.38 | (0.255) | 2.44 | (0.242) | 2.536 | (0.224) |
| Proportion of Children under 15 | 0.181 | (0.035) | 0.179 | (0.034) | 0.187 | (0.034) | 0.189 | (0.033) | 0.194 | (0.027) |
| Proportion of Adults above 60 | 0.262 | (0.734) | 0.256 | (0.065) | 0.233 | (0.0633) | 0.220 | (0.064) | 0.200 | (0.051) |
| Touristic Area | 0.098 | (0.297) | 0.153 | (0.361) | 0.162 | (0.369) | 0.160 | (0.367) | 0.096 | (0.294) |
| Urban Area | 0.133 | (0.34) | 0.092 | (0.29) | 0.117 | (0.321) | 0.139 | (0.346) | 0.249 | (0.433) |
| **B. Water Consumption and Expenditure** | | | | | | | | | | |
| Mean Annual Consumption | 136.145 | (57.52) | 132.738 | (49.972) | 135.97 | (98.144) | 139.527 | (70.748) | 139.541 | (57.964) |
| Mean Annual Expenditure | 192.651 | (80.63) | 187.527 | (70.231) | 191.193 | (96.62) | 188.668 | (81.585) | 196.66 | (80.444) |
| Expenditure as a Fraction of Income | 0.009 | (0.004) | 0.007 | (0.003) | 0.007 | (0.004) | 0.006 | (0.002) | 0.005 | (0.002) |
| Marginal Price | 1.074 | (0.32) | 1.065 | (0.324) | 1.087 | (0.351) | 1.058 | (0.324) | 1.154 | (0.337) |
| Fixed-Price | 48.93 | (27.175) | 49.456 | (27.198) | 48.79 | (27.176) | 44.119 | (24.758) | 38.611 | (23.905) |
| **C. Water Utilities Characteristics** | | | | | | | | | | |
| Proportion of Privately Managed | 0.658 | (0.475) | 0.612 | (0.488) | 0.63 | (0.483) | 0.634 | (0.482) | 0.69 | (0.463) |
| Underground Water | 0.739 | (0.439) | 0.688 | (0.464) | 0.652 | (0.477) | 0.653 | (0.476) | 0.574 | (0.494) |
| Ground Water | 0.10 | (0.30) | 0.144 | (0.352) | 0.136 | (0.343) | 0.152 | (0.359) | 0.15 | (0.357) |
| Treatment Complexity[a] | 2.919 | (1.299) | 2.935 | (2.990) | 2.990 | (1.285) | 3.006 | (1.238) | 3.184 | (1.281) |
| Net Revenues per Customer (Subsample) [b] | 23.959 | (27.079) | 29.618 | (33.055) | 27.058 | (27.797) | 26.416 | (26.291) | 25.736 | (29.694) |

Note: These municipal-level data come from IFEN-SOeS, INSEE and OSEA datasets. The sample includes 4,500 municipalities, 900 per quintile, except for the subsample on marginal cost, that includes data for 650 cities. These municipalities represent 16.7 million households. The first per-unit of consumption quintile of municipalities represent 3,319,712 households; the second 3,105,233; the third 3,315,489; the fourth 2,941,573 and the top quintile 3,970,965. Means and standard deviations (in parentheses) are calculated using 2008 euros.

[a] For ease in reading, there are six possible treatments numbered from 1 to 6, treatments 1 to 3 are easy, 4 and 5 are complex and 6 is intermediary complex. Water treatment performed by the operator before the water is distributed are important cost-shifters. Indeed, water treatment does not only approximate the complexity of service provision but also the level of specific investments needed to operate the service. A telltale story is that underground water is generally more stable over time which has two advantages. First, it reduces uncertainty about the evolution of costs. Second, treatment costs are usually lower when water is pumped from the underground. Under mixed sources of water, costs might be higher than under ground or underground sources as the utility might need a treatment factory for each type of water. Treatments are sixfold and coded between 1 and 6 in the IFEN-SOeS dataset. In the simplest case, there is no treatment. In this case, the *treatment* variable takes value 1. When raw water needs disinfection, *treatment* takes value 2. The value is equal to 3 if raw water needs a heavy disinfection treatment and equals 4 if water needs a heavy disinfection treatment plus extra-controls. The variable takes 5 and 6 when mixed treatments are needed, the most difficult treatment being 5.

[b] Fulfilled for the subsample including costs and revenues.

0.001. Overall, the test provides strong evidence of average consumption levels lower than the second-tier of the marginal price. The hypothesis of a single unit price experienced by households is thus validated.

Table 4.2: A test of non-linear pricing schemes in the French public water services

| $H_0$ | Degrees of freedom | Pr$\neq$H$_0$ | Confidence Interval |
|---|---|---|---|
| Consumption $\succ$2nd-tier threshold | 1270 | 100% | 0.001 |

Note: $H_0$ is the hypothesis that the average consumption is higher than the threshold of the second-tier of the tariff. We reject the null hypothesis with a confidence interval of 0.001.

### INSEE database

The INSEE database gives us information about household characteristics at the municipal level that is presented in Panel (A) of Table (4.1). We have the number of households, the population structure of the municipality and median income per households. We will briefly discuss the representativeness of this dataset.

We use median declared fiscal incomes as a proxy for a typical household standard of living. Incomes include labor and capital incomes before tax and deductions and do not include cash and non-cash benefits from public assistance. We however assume that income is a good proxy for the standard of living. Using weighted incomes, we find a median income of 17,923 for a single person, while the standard of living - including benefits and subtracting taxes - is 17,170 according to INSEE. However, our measure of incomes has two drawbacks. First, it is upward biased for low-income as the average income in the lower quintile is higher than it is for the standard of living (14,275 versus 10,530 euros). Second, it is downward biased for higher incomes as the average income in the top quintile is lower than the one of the standard of living (23,755 versus 35,580 euros). Our measure of household incomes is thus more concentrated than the distribution of the standard of living.

In order to gauge the financial stress on poor households, we must measure the impact of water tariffs on a household adjusted for its composition. To do so, we took into account household composition at the municipal level to compute an income per consumption unit. INSEE defines consumption units in the following way: household members aged less than 15 years old count for 0.3 unit, the first household member aged more than 15 counts for a single unit and other members aged more than 15 count for 0.5 unit. We can thus build an adjusted household income which takes into account that there are differences in the standard of living across households depending on the number of household members. Panel (A) in Table (4.1) shows that demographic structures are quite similar except for the proportion of adults above 60 that is higher in lower quintiles.

INSEE defines the poverty threshold as an income of 9804 euros per year for a single unit of consumption for 2008. As we consider median municipal incomes before taxes and without subsidies or benefits at the municipal level - we cannot take into account isolated single parents with children - where poverty is usually higher. Using municipal-level units, we have to consider reforms regarding “poor cities” rather than poor households.

There are no formal definitions of what a “poor city” is. Studies made by INSEE usually define poor cities as cities with high-level of unemployment, a large share of households living on public benefits and annual incomes per households below 12,000 euros. For simplicity, we consider as “poor” cities with a median income per unit below the minimum wage for a full-time employed person, that is 12,450 euros a year[52]. In our dataset, “poor cities” are

[52]In 2008, the minimum wage in France is 1,037.53 euros per month corresponding to 12,450.36 a year

thus cities with at least 50% of their households not earning the full-time minimum wage per unit. This definition is restrictive for several reasons. One that can be particularly strengthened is that it does not take into account inequalities within cities, as could approximate consumer-level studies. In this case, a high price of water can have no negative impact on the average consumption of the city and at the same time be very distortive for poor consumers. However, using a municipal-level analysis is useful for at least two reasons. First, as there is no national regulator, prices could tend to be higher in rural areas with incomes generally lower than in large cities such as Paris or Lyon. Second, cities represent an interesting laboratory to simulate the impact of the rebalanced tariffs. In the latter case, one could extend the municipal-level results to the district-level within a given city. Overall, city-level data provides a large heterogeneity in prices and consumption.

### OSEA database

To better understand water rate schedules in France, data on revenues, costs, the number of customers and billed volumes has been collected for 139 big water utilities for 2009. The data collection proceeded as follows. We launched a data collection on the top 720 cities in France, representing 320 water utilities. We got data for 297 and, because of missing data, obtained a complete sample of 139 water utilities. As these water utilities all include at least one city with 15,000 inhabitants, they usually share their network with small cities around. We finally have a dataset covering revenues and costs for 650 cities of the IFEN-SOeS dataset. For 139 water utilities, the dataset contains information about the global revenues and costs so one can compute a net revenue equal to revenues minus costs. It is impossible to have detailed information about costs and investments in order to extract water production and distribution costs on the one hand and capital cost on the other hand. The dataset is completed using numerous variables that we can find also in the IFEN-SOeS database such as the number of customers, billed volumes of water and water production specific indicators such as water sources and treatments.

OSEA dataset is useful to have information about the cost structure of the 4,500 IFEN-SOeS cities. However, we have to make several assumptions. First, we assume that marginal costs and revenues are moving in the same way between 2008 and 2009 as our data was mostly available only for 2009. Second, data is often aggregated at the contract level. A contract usually implies water production and distribution for several cities, i.e. a territory. So one might assume that customer density and consumption habits are the same from one city to another within the same territory, which is not always the case. When it is possible to split cities one from another, we do so. Thirdly, we have sometimes data aggregating different contracts from the same operator within the same territory. This case is particular because *marginal costs* are the same within the territory but *marginal prices* differ from one contract to another while we are only able to extract one marginal price for the whole territory. Finally, we have to assume that results issued from the OSEA database have an external validity and are thus expandable for the other French municipalities. The next subsection discusses the potential selection-bias that can occur from this study.

### Sample-Selection Bias

Due to data collection, our merged sample is truncated. One question that arises is whether results from this sub-sample can be generalized to the whole representative sample. To check the sub-sample external validity, we apply a simple Heckman [1979] selection model. In the first stage, we use a Probit model of the probability of observing the data regarding a function of regressors independent from observed marginal costs. The selection equation is:

$$V_i = \beta_0 + \beta Z_i + \eta_i \tag{4.2}$$

where $V_i$ is a latent variable equal to one if the city is included in the sample, $\beta$ the vector of coefficients for the selection equation, $Z_i$ the vector of covariates for city $i$ and $\eta_i$ the random disturbance for a given city $i$. The vector of independent covariates includes dummies for the urban, semi-urban or rural status and a dummy equal to 1 if water is privately managed.

The second-stage of the model regresses net revenues per customer on billed water per customer to test for marginal cost pricing. A similar model is used in Borenstein and Davis [2011] and Davis and Muehlegger [2010] for example. The following equation gives us the average margin per billed unit and per customer:

$$NRC_i = \alpha_0 + \alpha_1 q_i + \alpha_2 X_i + \Phi_i \epsilon_i \tag{4.3}$$

where net revenue per customer from water sales, $NRC_i$, is regressed on the annual consumption per customer of a given utility, $q_i$. $X_i$ is a vector of variables shifting costs - treatment types and water origins - crossed with the consumption per customer $q_i$ and $\Phi_i$ is the inverse Mills ratio derived from the selection equation. The coefficient $\alpha$ is the average mark-up per unit i.e. the difference between marginal prices and operating costs. We exploit differences in water sources and water treatments to generate different mark-ups[53]. The constant $\alpha_0$ is the average extra-amount paid in fixed fees, i.e. the difference

[53] In other regressions, we also included dummies for touristic areas, operators or whether municipalities are interconnected, but the results remained stable. In order to keep an intelligible form of the cost function, we decided to apply a simple model focusing on production costs.

between fixed fees and capital expenditures. The inverse Mills ratio $\Phi_i$ makes this mark-up on fixed price vary from one city to another.

Table (4.3) shows the Heckman-selection regression results. Results can be interpreted in the following way. From the selection equation, we observe that our sub-sample tends to over-represent semi-urban, urban and privately managed cities. The highly-significant coefficient of the inverse Mills ratio means that there was a selection bias from our sub-sample. We can however control for this bias by correcting our predicted results from the second-stage equation. Results from the test of marginal cost shows that marginal prices tend to differ from marginal costs. Indeed, for each volumetric unit sold, a consumer pays on average 0.1239 euros more than the marginal cost of water provision. Considering cross-variables, bad water quality seems to be positively marked-up on per-unit prices while more complex treatments lead to lower per-unit mark-ups. Regarding fixed prices, interpreting the sign of the mark-up is less straightforward: while the constant suggest a negative loss for water producers, the inverse Mills ratio has a significant positive coefficient. Using the model and the coefficients from the regression, we build counterfactual bills using a second database with 4,500 observations at the municipal level. The results are detailed in the next section.

## 4.4 Switching to Marginal Cost Pricing

### Graphical Analysis

In this subsection, we use computed city-level natural water consumption and expenditure to describe the rate schedules faced by French residential customers. Figure (4.1) plots a fitted least squares regression line of average annual consumption and expenditure (the solid line). There is large variation

Table 4.3: A test of marginal cost pricing in the French public water services

| Variables | *NRA* |
|---|---|
| $q$ | 0.218*** |
| | (0.0499) |
| $q \times$ Ground Water | 0.0247 |
| | (0.0181) |
| $q \times$ Mixed-Water | 0.0673*** |
| | (0.0150) |
| $q \times$ Treat2 | -0.0874*** |
| | (0.0492) |
| $q \times$ Treat3 | -0.152*** |
| | (0.0470) |
| $q \times$ Treat4 | -0.183*** |
| | (0.0444) |
| $q \times$ Treat5 | -0.121*** |
| | (0.0437) |
| $q \times$ Treat6 | 0.0756 |
| | (0.0663) |
| $\Phi$ | -7.961*** |
| | (2.844) |
| Constant | -13.29* |
| | (7.301) |
| N | 650 |
| $R^2$ | 0.362 |
| Marginal effect of $q$ | 0.1240*** |
| | (0.0232) |

**Results from the Selection Equation**

| Variables | *V* |
|---|---|
| Semi-Urban | 0.759*** |
| | (0.0652) |
| Urban | 1.654*** |
| | (0.0722) |
| Private Management | 0.597*** |
| | (0.0603) |
| Constant | -2.278*** |
| | (0.0691) |
| N | 5,215 |
| Pseudo $R^2$ | 0.1991 |

Robust Standard Errors in Parentheses
*** p<0.01, ** p<0.05, * p<0.1

across households in annual consumption but the figure shows a strong correlation between consumption and expenditure. There is, however, a large degree of heterogeneity in expenditure across the country. In many cases, different households consuming the exact same amount of water in the same basin pay considerably different amounts. Costs may vary across utilities based on the mix of residential, commercial and industrial customers, scale economies, age of the meter and transportation costs when water is imported. Once again, data are computed from overall municipal consumption and not from customers' bills. Several limitations result: we cannot consider whether seasonal differences in consumption have an impact on the average annual bill for example; we can neither compare bills from different households of the same city. We can only conclude on differences on the typical bill of a consumer in a given city.

For simplicity, we assume that consumption elasticity is null and that revenue is neutral to consumption. A simple reason why null consumption elasticity can be a reasonable assumption is that consumers can have limited attention to complex and less salient price incentives. This situation arises when consumers do not know their marginal price of water (Carter and Milon [2005]). While several studies assume that income and water consumption are strongly related (Diakité et al. [2009] for example), this assumption can be relaxed here by the fact that income and water consumption are weakly correlated. Figure (4.3) in appendix at the end of the chapter plots an fitted least square of the two variables. Each observation is a city. The figure illustrates a positive correlation but little of the variation in water consumption is explained by income variation. The OLS regression reveals a 0.0006 $R^2$. Part of this lack of correlation comes from differences of consumption in geographic divisions. However, even in the same regions, income explains a small fraction of the variation in water consumption. This weak correlation illustrates the difficulties to have strong distributional impacts with tariff reforms. Any tariff reform must take into account household composition and structure to target water assistance programs and have stronger equity effects, something that we consider using per-unit income.

In Figure (4.1) in appendix, the dashed-line plots the bill faced by households under marginal cost pricing. As the fitted least square line is flatter under marginal cost pricing, customers consuming the same amount of water than in the current rate scheme would face significantly lower bills. Overall, less than 3% of customers would face higher prices under marginal cost pricing. Households with low levels of annual consumption could face increasing bills due to higher fixed-fees, while household with high levels of annual consumption would tend to pay less. In the following subsection we examine distributional consequences in detail, comparing the characteristics of households with different levels of incomes, household composition and consumption.

Factors that can create differences in rate schedules are urban density and organizational choice to provide water. Figure (4.2) in appendix shows different bills reflecting alternative consumption in rural (solid black line), semi-urban (dash line) and urban (dash-dot line) areas when the utility is publicly and privately managed. This graph does not take into account controls for selection effects that could explain differences in rates between public and private management. However, one can see that under private management, the slope of the line is higher than under public management, meaning that prices increase faster under private management. Another noteworthy element is that under private management, urban areas face higher marginal prices than semi-urban areas.

Table (4.4) describes the rate schemes for different types of water utilities. We present marginal and fixed prices for different organizational choices and different consumption density. The unit of observation is a municipality. Results are unweighted by the number of households. So when considering marginal price in public and private management for example, we consider average price between municipalities, not between households. Household-level results would be different as there are heterogeneity in the number of inhabitants between and within the different categories. For example, if all the inhabitants of Paris support an increase in prices, this has a more important impact at the national level than it could have in a small city. However, as the nature of our data is municipally-leveled, we present change in tariffs at the city-level.

The first column shows current water tariffs while the second column gives the rebalanced rate schedules when the Coasian tariff is implemented. In many cases, different households consuming the exact same amount of water in the same region pay considerably different amounts. This heterogeneity in water prices is at first sight surprising. In most cases, water production is quiet cheap and does not change a lot across regions or basins. However, differences arise from the cost of local distribution and other fixed costs that are recovered in the utility's volumetric charge or fixed costs. The difference in per-unit price between public and private management is a little bit more than 18 cents, representing a 16.8% deviation from mean price. The gap between private and public management is even wider when one considers the fixed-part of the tariff. There is indeed a 12.63 euros difference per customer, representing a 27% deviation from the mean fixed-price.

In column (2), marginal tariffs are rebalanced such as the water indus-

Table 4.4: Rate Schemes Implemented in Different Types of Water Utilities

| | Current Rate Scheme (1) | | | | Reformed Rate Scheme (2) | | | |
|---|---|---|---|---|---|---|---|---|
| | Marginal Price | | Fixed-part | | Marginal Cost | | Capital Cost | |
| Public Management | 0.968*** | (0.00725) | 38.04*** | (0.543) | 0.814*** | (0.00771) | 33.31*** | (0.532) |
| Private Management | 1.151*** | (0.00632) | 50.67*** | (0.529) | 1.032*** | (0.00647) | 50.37*** | (0.490) |
| Rural | 1.097*** | (0.00734) | 57.81*** | (0.604) | 0.950*** | (0.00772) | 52.14*** | (0.60) |
| Semi-Urban | 1.054*** | (0.00793) | 37.04*** | (0.899) | 0.920*** | (0.00822) | 37.33*** | (0.517) |
| Urban | 1.151*** | (0.0123) | 34.89*** | (0.516) | 1.065*** | (0.0133) | 38.94*** | (0.922) |

Note: This table reports how customers expenditure on water would change under Coasian tariffs. Bootstrap standard errors based on 1000 replications in parentheses with *** p<0.01, ** p<0.05, * p<0.1.

try tend towards to a null profit, in the idea of Coase [1946]. In column (2), the reformed rates are derived from the marginal cost model corresponding to equation (1) and Table (4.3). All prices logically decrease on average but some heterogeneity is found between organizational choices and different consumption densities. While marginal prices decrease in rural areas, they tend to increase in urban areas and to remain stable in semi-urban areas.

On average, marginal price is set 0.154 euros higher than marginal cost under public management while unit price is 0.119 higher than marginal cost under private management. Differences between organizational choices are higher under marginal cost pricing: on average, unit price under private management will be 0.218 euros more expensive while it is 0.183 under current rates. Public managed utilities thus tend to have higher per-unit margins than privately managed utilities. The gap between public and private management is even wider if one considers the fixed-part of water rates. While in column (1), the gap is 12.63 euros, it is 17.06 euros in column (2). One might consider that this wider gap between public and private management is counterintuitive. In the public debate, public management is often viewed as being cheaper because it has lower margins than private management. We argue here that per-unit prices under public management could be even cheaper while private managers tend to keep low per-unit margins to remain competitive[54].

Another factor that creates differences in rate schedules within divisions is population density. Consumers in urban areas face higher unit prices than consumers in rural areas. The gap is however balanced by the differences in

[54] Accounting rules in public budget are clear. All margins are automatically used to fund next year operating expenses or can be used as provisions for future investments. However, these provisions i) are against lower prices for consumers, ii) do not represent the cost of water supply and are distortive and iii) do not imply larger investments under public management.

fixed costs. Urban customers pay on average 34.89 euros per year for their subscription while rural customers pay 57.81 euros per year. This is surely because a part of fixed costs in urban areas is recovered by the volumetric charges while in rural areas where consumption density is lower, utilities secure their revenues through high fixed tariffs. Note that rural areas represent 40% of our observations but only 1,670,649 households versus 9,391,694 households living in urban areas and 5,590,629 living in semi-urban areas. Even if cities experience on average decreasing fixed fees, households experience overall increasing fixed fees when they switch from current tariffs to Coasian rates. Column (2) shows that current water tariffs are far from being well-designed and could be rebalanced in order to slightly increase fixed-price and lower marginal prices. This would also fit firms' willingness to ensure sustainable profits using access fees and to maintain the optimal level of investments[55].

### Counterfactual Bills

Table (4.5) describes the distributional impact of a change to marginal cost pricing assuming zero demand elasticity. Panel (A) reports results by household income quintile. Households in the first quintile would pay on average 22.32 euros less under marginal cost pricing and only 1.1% of the households of this quintile would experience a bill increase. Households in the fifth quintile would experience smaller decreases in bills and 4.67% of this class would experience increase in prices.

Results in panel (B) by adjusted income quintile are somewhat similar to the previous results. When one considers household composition, households in the first quintile face larger decreases in bills than households from the fifth

[55] One of the theoretical features of public-private contracts is that, in a principal-agent model, the agent in charge of providing the service will underinvest if it has no incentives to do other.

Table 4.5: Impact on Bills of Rebalanced Tariffs

| | **Mean Change in Euros** | | **Mean Change in Percent** | | **% Experiencing Bill Increase** | |
|---|---|---|---|---|---|---|
| **A. By Income Quintile** | | | | | | |
| 1st Quintile | -22.32*** | (0.709) | -12.43*** | (0.336) | 1.332*** | (0.377) |
| 2nd Quintile | -21.36*** | (0.541) | -11.97*** | (0.289) | 1.332*** | (0.389) |
| 3rd Quintile | -20.89*** | (0.697) | -11.58*** | (0.320) | 2.558*** | (0.534) |
| 4th Quintile | -19.33*** | (0.465) | -11.28*** | (0.284) | 3.444*** | (0.586) |
| 5th Quintile | -16.95*** | (0.482) | -9.563*** | (0.271) | 4.672*** | (0.706) |
| **B. By Adjusted Income Quintile** | | | | | | |
| 1st Quintile | -21.45*** | (0.598) | -11.95*** | (0.319) | 1.776*** | (0.440) |
| 2nd Quintile | -21.85*** | (0.545) | -12.56*** | (0.313) | 1.333*** | (0.388) |
| 3rd Quintile | -21.57*** | (0.747) | -11.93*** | (0.305) | 1.556*** | (0.423) |
| 4th Quintile | -20.07*** | (0.514) | -11.45*** | (0.275) | 2.667*** | (0.528) |
| 5th Quintile | -15.90*** | (0.498) | -8.933*** | (0.265) | 6.007*** | (0.820) |
| **C. By Consumption Quintile** | | | | | | |
| 1st Quintile | -12.99*** | (0.305) | -9.401*** | (0.260) | 4.329*** | (0.686) |
| 2nd Quintile | -16.39*** | (0.315) | -10.73*** | (0.242) | 2.000*** | (0.466) |
| 3rd Quintile | -18.29*** | (0.396) | -11.50*** | (0.287) | 1.444*** | (0.416) |
| 4th Quintile | -20.88*** | (0.478) | -11.94*** | (0.315) | 2.667*** | (0.528) |
| 5th Quintile | -32.32*** | (0.953) | -13.25*** | (0.370) | 2.892*** | (0.536) |
| **D. By Poverty Status** | | | | | | |
| Water-Poor | -54.26*** | (5.272) | -10.96*** | (0.880) | 0 | |
| Poor Cities | -22.19*** | (1.434) | -11.68*** | (0.765) | 2.030*** | (0.988) |

Note: This table reports how customers expenditure on water would change under Coasian tariffs. Bootstrap standard errors based on 1000 replications are shown in parentheses with *** p<0.01, ** p<0.05, * p<0.1. In panel (D), water-poor are defined as cities in which the average water bill represents more than 1.5% of the household median income. Poor Cities are defined as cities in which the annual median per-unit income is lower than 12,450 euros a year. Poor and water-poor cities represent respectively 576,399 and 126,466 households.

quintile. The former would annually pay 21.45 euros less while the latter would pay on average 15.90 euros less. The pattern of the change comes from the fact that lower adjusted income quintiles can be those with higher consumption if the lower income is due to numerous members in the household. For example, a family of two adults and three children would have a lower adjusted income than in panel (A) while their consumption would remain the same.

Panel (C) examines consumption quintiles. As Figure (4.1) in appendix shows, the transition from current tariffs to marginal cost pricing is assumed to advantage households consuming the biggest amount of water. The first quintile in panel (C) has a probability of 4.33% of experiencing increase in bills because of increasing fixed-prices. Panel (D) focuses only on water-poor and poor cities. Applying marginal cost pricing leads to lower prices for water-poor and households below the poverty line. Municipalities with water-poor experience a 54.26 euros decrease in their bills and municipalities with incomes below the poverty line experience a 22.19 euros decrease in their bills. The gap between the two groups of households comes from the fact that water poverty is correlated with consumption and incomes while the poverty line depends only on income considerations. A few municipalities with water-poor citizens or median incomes below the annual minimum wage experience increased bills under Coasian tariffs.

Even if Table (4.5) is instructive to understand the impact of reformed tariffs, there are two drawbacks to the correct interpretation of the table. On the one hand, one might argue that household income may not be a good indicator of the financial stress that households face. Cutler and Katz [1992] state for example that permanent income is a more accurate measure of the distribution of resources than current income. Poterba [1989] argues that households can base their spending on their expected lifetime income, meaning that consumption would provide a more accurate measure of households' resources. On the other hand, our residential approach to water consumption does not take into account households' appliances, that can be a proxy for expected lifetime income. There is unfortunately no available data on durable goods owned by households at the municipal level. However, this could be an interesting point to explore using a household-level dataset. Ideally, we could also have information on consumers' housing such as the number of bathrooms they have, whether they rent or own their housing and whether they live in multiple-unit buildings or not.

#### Including Water Assistance Programs

Table (4.5) gives clear-cut results in favor of efficient pricing for consumers. However, its redistributive impact can be considered insufficient and can be criticized in terms of outcomes for operators who would experience substantial profit losses. In this section, we consider that the regulatory profile would ensure marginal cost pricing for the volumetric charge. We then assume two situations corresponding to Part I and Part II in Table (4.6). In Part I, a Coasian tariff is implemented and firms have to bear null profits in favor of consumers. In Part II, we assume that firms charge per-unit consumption at the marginal cost but increase fixed fees in order to maintain the same level of profits than under current tariffs. We run four reforms that could be discussed at the national level. In panels (A) and (B) of Part I, we consider two reforms. The first one provides free fixed fees for households in poor cities. The second one consists in a refund of increased fixed fees that can result from Coasian tariff schedules, no matter if the city is considered as being poor or not. The result of the later reform can be expressed in the following way. Cities with increased fixed fees under rebalanced tariffs will be funded in order to face the current fixed fees. We then compare their distributional impacts regarding current price schedules.

In panel (C) and (D) of Part II, we consider marginal cost pricing with increased fixed-fees such as water industries keep the profits constant and we apply a free-fixed fees policies for poor cities and for cities with median incomes below 159% of the poverty line. Table (4.6) reports the results of these simulations on five categories: cities with median income below 159% of the poverty line, water-poor cities, poor cities, the annual cost per non-recipient and the overall cost in millions.

Panel (A) in Table (4.6) shows the impact of free-fixed fees on poor cities before rebalancing tariffs. Because households below the poverty line represent 576,399 households out of 16.7 million in our dataset, it is relatively costless to fund a free-fixed fee policy by non-recipient households. The impact on tariffs in poor cities is a decrease of 29.14% of the water bill, representing 50.51 euros. On average, cities with a median income below 159% of the poverty line experience a decrease of their water bill by 9.372 euros per year but 79% of this category has to participate in the funding of poor cities. The annual cost per non recipient is 1.44 euros per year for an overall cost of 23 million euros.

Panel (B) is the case in which tariff reform is guaranteed with no increase in fixed-fees in any city regarding the current tariffs, no matter whether the city is considered poor or not. In this case, households living in a municipality within the first quintile face an average decrease of 0.33 euro in their annual bills. Poor cities experience a decrease of 1.25 euros on average of the water bill and no poor cities would experience increased tariffs, meaning that poor cities are all cities facing increasing fixed rates when we switch from current to Coasian tariffs. The annual cost of this program is 1.20 euros per non-recipient

Table 4.6: The Impact of Four Reforms on Lower Incomes

| | Mean Change in Euros | | Mean Change in Percent | | % Experiencing Bill Increase | |
|---|---|---|---|---|---|---|
| **I. Assistance Programs Under Coasian Tariffs** | | | | | | |
| **A. Free Fixed-fees for Poor Cities** | | | | | | |
| 20% lower per-unit incomes | -9.372*** | (0.824) | -5.299*** | (0.455) | 79.02*** | (1.368) |
| Water-poor | -14.79*** | (3.394) | -4.221*** | (0.969) | 79.05*** | (3.990) |
| Poor Cities | -50.51*** | (1.813) | -29.14*** | (0.908) | 0 | - |
| Annual cost per non-recipient | 1.442*** | (0.000) | 0.999*** | (0.007) | 100 | - |
| Overall Cost (in millions euros) | 23.2*** | (0.000) | - | - | - | - |
| **B. No Increase in Fixed Fees** | | | | | | |
| 20% lower per-unit incomes | -0.329*** | (0.072) | -0.168*** | (0.053) | 79.02*** | (1.368) |
| Water-poor | -1.252*** | (0.349) | -0.245*** | (0.091) | 79.05*** | (3.990) |
| Poor Cities | -0.245*** | (0.151) | -0.082*** | (0.102) | 0 | - |
| Annual cost per non-recipient | 1.204*** | (0.000) | 0.870*** | (0.008) | 100 | - |
| Overall Cost (in millions euros) | 19.4*** | (0.000) | - | - | - | - |
| **II. Assistance Programs Under Marginal Cost Pricing and Current Profits** | | | | | | |
| **C. Free Fixed Fees for Poor Cities** | | | | | | |
| 20% lower per-unit incomes | -21.12*** | (1.876) | -8.318*** | (0.672) | 79.02*** | (1.368) |
| Water-poor | -35.56*** | (7.837) | -7.653*** | (1.658) | 79.05*** | (3.990) |
| Poor Cities | -107.73*** | (4.954) | -43.63*** | (1.288) | 0 | - |
| Annual cost per non-recipient | 1.901*** | (0.000) | 1.065*** | (0.006) | 100 | - |
| Overall Cost (in millions euros) | 30.60*** | (0.000) | - | - | - | - |
| **D. Free Fixed Fees for Cities with Median Income <159% of the Poverty Line** | | | | | | |
| 20% lower per-unit incomes | -88.15*** | (1.855) | -40.98*** | (0.565) | 0 | - |
| Water-poor | -81.73*** | (8.874) | -19.23*** | (2.011) | 43.81*** | (4.657) |
| Poor Cities | -102.99*** | (5.242) | -41.69*** | (1.448) | 0 | - |
| Annual cost per non-recipient | 11.86*** | (0.000) | 6.642*** | (0.040) | 100 | - |
| Overall Cost (in millions euros) | 166*** | (0.000) | - | - | - | - |

Note: This table reports how customers expenditure on water would change under Coasian tariffs in part (I) and under marginal cost pricing with increased fixed fees such as firms' profit is unchanged in part (II). Bootstrap standard errors based on 1000 replications are shown in parentheses with *** p<0.01, ** p<0.05, * p<0.1. Costs per non-recipients are computed using weights for the number of households. The 20% cities with the lower incomes represent 3,319,712 households; Poor and Water-poor cities represent respectively 576,399 and 126,466 households.

household and the overall cost is 19.4 million euros, both are below what is observed in panel (A). Costs of reforms in panels (A) and (B) are comparable but they do not target the same cities. Programs described in panel (B) will especially advantage urbanized areas that are more represented within the 5th quintile (a quarter of the cities) than within the 1st quintile (around 13% of the cities) as it is shown in Table (4.1).

Results in Part I of Table (4.6) provide a better understanding of the costs of tariff reforms. While households would on average largely benefit from Coasian tariffs, small consumers could be disadvantaged regarding large consumers. Panels (A) and (B) give solutions to mitigate the distributional impacts of reforms. Note that these reforms could be implemented under current tariffs.

In part II of Table (4.6), we assume marginal cost pricing and rebalanced fixed fees such as firms do not support profit losses under the 0-demand elasticity assumption. In this case we assume marginal cost pricing for the volumetric charge and higher fixed fees to maintain constant profits for the firm. One of the arguments against marginal cost pricing when firms maintain their profits is that it results in larger fixed fees that can affect particularly poor households. We offer here two alternative reforms that can mitigate the distributional impacts of a transition to marginal cost pricing with a significant increase in fixed fees. This solutions can associate efficiency in pricing at marginal cost and equity by decreasing bills in poor cities.

Panel (C) shows the result of a free fixed fee policy in poor cities funded by non-poor cities' households. Because of increased fixed fees for all the households, cities within the first quintile and poor cities would experience larger decreases in their bills. The cost per non-recipient would be 0.46 euro higher. For the same level of consumption, each household in non-poor cities would have to pay 1.90 euros more than under current pricing. Overall costs are 30.60 million euros, 7 million more than under Coasian tariffs.

Panel (D) shows the impact on water bills of a free fixed fees policy for cities with a median income in the first quintile. In this case, the scope of the policy is wider as the number of households targeted largely outpasses the number of households living in poor cities (3,319,712 vs. 576,399 households). As one can expect, the policy has a larger impact on the mean annual bill of cities within the first per-unit income quintile with an average decrease of 88.15 euros per year. The annual cost per non-recipient is 11.86 euros, representing 6.64% of the typical bill of a non-recipient, a 166 million euros overall annual cost. Matching efficiency with equity is thus possbile if the implementation of marginal cost pricing for the volumetric charge is combined with transfers between cities.

Under rate reforms such as those presented in panel (C) and (D), poor cities would experience larger decreases in their annual water bills at a low cost for a non-recipient. In more ambitious reforms such as the one presented in panel (D), cities with median incomes in the first quintile would have average bills decreased by more than 69 euros, a result that is more than three times higher than under marginal cost and capital cost pricing without water assistance programs. These results suggest that it may be possible for water assistance programs to take into account distributional considerations without losses of revenues for water utilities, a solution that is more credible than perfect Coasian tariffs.

Nevertheless, designing consistent water assistance programs is difficult. First, threshold-effects are important. Households in cities with incomes just above the defined poverty threshold would face increased tariffs to fund households below the poverty line. Second, it implies that water utilities fix their rates considering household incomes instead of their costs. Even if they were subsidized by other customers, this would imply limitations in their capacity to negotiate contracts that reflect their needs.

It is also worth emphasizing that these mean impacts obscure substantial heterogeneity across households. Because households differ substantially in their level of water consumption, the lump sum payment can be far too much for small consumers and not incentive enough to sustain water resources for others. Moreover, utilities differ in their needs to invest in capital. Suppressing fixed-fees for a whole set of utilities, even if they get national subsidies, could be alarming as the level of investments would depend on other subsidies rather than their capacity to raise fixed prices. Finally, these reforms would face political challenges, as municipalities are keen on administering their contracts, even if the proposed reform would probably better match the needs of poor households than the current tariffs. For all these reasons, efforts should go in the direction of efficient pricing, potentially closer to marginal cost pricing.

## 4.5 Welfare Effects of Changing Retail Prices

In order to evaluate the total deadweight loss from the observed departures from marginal cost and capital cost pricing, we first estimate the price-elasticity of demand for each per-unit of consumption income quintile. We then calculate the welfare changes and the deadweight loss associated with the current pricing schedules compared to efficient pricing.

Consumer elasticities

The counterfactual bills we have considered thus far show how household expenditure on water would change under marginal cost pricing if demand elasticity were zero, which implies huge efficiency consequences of the change. With non-zero elasticity, it is interesting to see whether households would consume more water, thus leading to a proper deadweight loss. Table (4.7) reports demand elasticities for the five household adjusted-income quintiles. In order to compute elasticities, we regressed the log of annual consumption per household on the logs of marginal price, income and demand shifters such as regional fixed-effects, urban density, touristic area, household size and the share of population aged between 15-64 years old.

Demand is significantly negatively correlated with marginal prices. The elasticity point estimates for the first quintile is -0.281 while it is -0.223 for the last quintile. The second and the third quintile face higher elasticities than the first one with respectively -0.287 and -0.304. These results are consistent with previous studies on the French water market (Nauges and Thomas [2003]; Garcia and Reynaud [2003]) but also in developing countries (Nauges and Whittington [2009]) and other markets such as gas or electricity in the USA (Borenstein and Davis [2011]; Ito [2010]). This estimation includes income elasticity by using crossed variables between per-unit of consumption quintiles and marginal prices. Even if one could consider linear effects of income elasticity, here we take into account different price-elasticity intensities following revenue distribution.

Municipalities' demographic and geographical characteristics have strong effects on water consumption. Regional fixed effects are significant to explain differences in level of consumption. Touristic areas are associated with higher

Table 4.7: Price-Elasticity of Demand

| Variables | Ln(Consumption) |
|---|---|
| Ln(MP) × 1st Quintile | -0.281*** |
| | (0.0332) |
| Ln(MP) × 2nd Quintile | -0.304*** |
| | (0.0325) |
| Ln(MP) × 3rd Quintile | -0.287*** |
| | (0.0324) |
| Ln(MP) × 4th Quintile | -0.269*** |
| | (0.0320) |
| Ln(MP) × 5th Quintile | -0.223*** |
| | (0.0314) |
| Semi-Urban | -0.163*** |
| | (0.0198) |
| Urban | -0.120*** |
| | (0.0181) |
| Household Size | 0.217*** |
| | (0.0300) |
| Touristic Area | 0.138*** |
| | (0.0167) |
| Share of Population 15-64 YO | -0.805*** |
| | (0.147) |
| Region FE | Yes |
| Constant | 5.120*** |
| | (0.0966) |
| Observations | 4,500 |
| R-squared | 0.197 |

Note: Robust Standard Errors in Parentheses.*** p<0.01, ** p<0.05, * p<0.1.
Demand Elasticity is computed for current marginal prices.

level of consumptions because of a high level of seasonal consumption. Urban and semi-urban areas tend to have less per-household water consumption than rural areas. Average household size and structure matters. The larger the number of family members, the larger the consumption. A large share of 15 to 64 year old inhabitants is also associated with lower levels of consumption, perhaps because cities with a lot of working inhabitants are often urbanized and thus correlated with less-consuming capital goods.

From our demand-elasticity results, we can conclude that changing retailing prices would improve economic efficiency as consumers would change their behavior in response to the price changes. The efficiency impact can however be limited because consumer behavior is difficult to predict, and decreased marginal prices do not automatically lead to increased consumption. This is especially true in cities experiencing increased fixed fees such as urbanized areas. Computing welfare changes implies taking into account the linear welfare impact of marginal-cost pricing, the increased consumption that results from lower prices and the change in fixed fees.

### Welfare Effects including Marginal Quantity Changes

Counterfactual bills presented so far showed welfare changes under the assumption of zero demand elasticity. In this subsection, we use elasticities from Table (4.7) to compute the deadweight loss of restrained water consumption due to inefficient pricing. We assume here that the tariff change does not lead any consumers to enter or exit the market. Table (4.8) reports deadweight loss generated by using existing pricing tariffs relative to marginal cost prices. We separately report mean welfare changes for each adjusted-income quintiles at the municipal level and for the whole set of households taking, weighting the municipal observations by the number of households. To compute welfare changes, we consider a constant elasticity for each income quintile. Price-elasticity is thus the same to a certain threshold of per-unit of consumption income. On average, in the sample, lowering the volumetric charge implies a 12% decrease. With a -0.22 to -0.3 price elasticity, this yields an increase in consumption of 5.5 cubic meters for the average consumer of a city compared to the initial level of 136.8 units. We consider the change in consumer welfare as the area to the left of the demand curve that computes the area of the difference between the original price and the marginal cost and the new level of consumption, and we substract the difference between annual fixed fees. The deadweight loss corresponds to the triangle ABC in figure (4.4) in appendix.

Table 4.8: Welfare Change and Deadweight Loss Estimates for 2008

| **Mean Annual Welfare Change in euros** | | |
|---|---|---|
| 1st Quintile | 22.31*** | (0.561) |
| 2nd Quintile | 22.98*** | (0.566) |
| 3rd Quintile | 22.63*** | (0.777) |
| 4th Quintile | 20.92*** | (0.526) |
| 5th Quintile | 17.06*** | (0.473) |
| Water-Poor | 52.94*** | (5.545) |
| Poor Cities | 24.53*** | (1.473) |
| Consumers' Welfare Change (in millions) | 201 | (0.000) |
| Deadweight Loss (in millions) | 5.358 | (0.000) |

Note: This table reports how customers welfare change for per-unit of consumption income quintiles. Bootstrap standard errors based on 1000 replications are shown in parentheses with *** p<0.01, ** p<0.05, * p<0.1. Consumers' welfare change under Coasian tariffs includes the deadweight loss and subtracts increased fixed fees. The deadweight loss is the net efficiency gains from marginal cost pricing.

Overall, the current marginal price schedule creates 5,357,913 euros in deadweight loss, relative to efficient pricing. The dataset represents a market of more than 16.7 million households and a gross market of 3.05 billion euros[56] so the deadweight loss represents approximatively 3% of the considered mar-

[56] For simplicity, we excluded taxes that are proportional to the volumetric consumption of water, such as value-added taxes but also a whole set of fees related to water production and distribution. When it is possible to dissociate domestic from industrial consumption, we do so. We also exclude sanitation and sewage from our analysis as we do not have information about the cost structure of these services.

ket. As a thought exercise, one can compute the deadweight loss for the whole water market in 2008 as the full dataset is representative of French municipalities. As there are 26.615 million households, the deadweight loss for the water market in 2008 could be set to 8 million euros for household consumption. Even in the case of counterbalanced fixed-part tariffs in order to maintain water industries' profits, the deadweight loss would remain the same, as it is the result of differences between marginal prices and costs. These results help clarify the overall debate about tariffs in France.

In Table 4.6, we find that a free-fixed fee policy in poor cities has an annual cost of 23 million euros under Coasian tariffs (see panel (A) in Part I of 4.6), while the efficiency cost of non marginal-cost pricing is 5.36 million euros. For the price elasticity of demand found above, the deadweight loss from transferring these funds is lower than 25%, meaning than the distortionary impact of a 20% take-up of fixed fees in poor cities for example could be offset under Coasian tariffs. Under marginal cost pricing with current profits, a full take-up of fixed fees in poor cities would cost 30.60 million euros (see panel (C) in Part II of 4.6). This is far more than the efficiency cost of current tariffs. In this context, water assistance programs could fund a minor part of fixed fees, e.g. a subsidy of 5 to 10 euros per household that could barely offset the negative impact of increased fixed fees.

The effect of marginal cost pricing on water conservation is also another feature of the deadweight loss analysis that must be discussed. Under marginal cost pricing and the assumption that customers respond to their marginal price, a typical household would consume 5.5 cubic meters more per year on average than under current tariffs, a result that goes against the argument for sustainable water use. In an extensive way, one could imagine that consumers paying cheaper bills would invest in less-consuming durable goods and thus promote water conservation.

These estimates provide a valuable preliminary assessment of the welfare consequences of the observed departures from marginal cost pricing. However, it is necessary to underline that the calculation of the deadweight loss is sensitive to the estimation of the elasticity demand. This has two limitations. First, demand elasticity might differ when one considers marginal price and average price (Borenstein [2010], Ito [2010]), or different estimates of long-term elasticity (Nauges and Thomas [2003]). We will discuss these limitations in the following section. Second, consumer elasticities assume that individuals respond to a pricing scheme in a way that the standard economic model predicts. Heckman [1983] shows for example that in nonlinear price schedules, the absence of bunching around the kink points could imply that individuals respond to other perceptions of price rather than the actual marginal price they are paying. Cognitive difficulties to understand rate schemes or simply missing information about their marginal price of water could also limit the possibility of evolving consumption when marginal price decreases.

### Possible Explanations for Maintaining Efficiency Costs

Departures from efficiency pricing may have three explanations (a similar discussion is made by Davis and Muehlegger [2010] for the US gas industry). The first one lies in firms' profit maximization. In the last years, water operators in France have been justifying the increasing marginal prices of water by the diminishing demand from consumers. Increasing marginal price was thus a means to maintain stable profits. Moreover, some argue that fixed fees are too large regarding capital costs because firms want to maximize their profits using fixed fees. The marginal cost of a new customer is indeed null and does not vary with the utilities' characteristics. In practice, small customers are sensitive to fixed fees while large customers are sensitive to unit fees when they make their demand decision. In Table (4.4), the transition from current schedules to Coasian pricing shows that utilities currently advantage small customers in urban areas and large consumers in rural areas. We undoubtedly lack information as we do not have the details about the stock of capital and the forthcoming investments. However, water companies have probably different pricing strategies depending on cost structures and water utilities' characteristics that can explain different styles in departures from Coasian tariffs.

Environmental considerations provide a second alternative explanation for setting high per-unit margins. In this view, departures from marginal costs could be justified by the need to address environmental externalities (such as water pollution) and sustainable water use[57]. In the standard view of externalities, the gap between marginal prices and costs is comparable to a Pigouvian tax that would reflect marginal damages. In this case, current tariffs[58] reflect the socially optimal level of exchange on the market because marginal prices equal the sum of private marginal costs and the costs of marginal damages. However, while this assumption is reasonable in competitive markets, they are less reasonable for regulated markets such as water in France. As noticed by Davis and Muehlegger [2010], in regulated markets, the standard Pigouvian solution is only verified and thus not distortionary if prices are set equal to marginal cost. An alternative view is that tariffs reflect the need for sustain-

[57]One might argue that the difference between marginal prices and marginal costs could reflect different level of leaks between utilities. As Garcia and Thomas [2001] noticed, when demand increases, utilities face two choices. On the one hand, they can repair leaks, which is costly as it is largely labor-intensive. On the other hand, they can produce more water, which is less costly as it is electricity-intensive. Utilities with low leak-ratio may have to deal with higher costs. This explanation can explain why utilities have different marginal prices, as some include water scarcity in their pricing strategies, but not why marginal prices and marginal costs differ.

[58]To the best of our knowledge, there are few studies evaluating the price of scarce resources. Moncur and Pollock [1988] consider for example the change of marginal cost that would occur at the complete use of the current water source. In their study, they consider that water demand would be satisfied through a desalination technology or a trans-basins diversion, leading to a marginal cost twice higher than the current one.

able water use, including a discount rate in current tariffs. However, recent renegotiations in France tend to prove that tariffs probably reflect more the market structure than the real need for sustainable use[59].

Moreover, in France, negative externalities and resource protection are considered in the tariff structure of water. Two fees, one to protect resources and one to struggle against pollution, have been implemented. These fees are per-unit taxes that finance Basin Agencies' in order to subsidize projects which struggle against pollution and ensure resource protection. The per-unit rates of these fees are fixed by the Agencies and depends on the geological characteristics of the Basin. These characteristics are the origin of water and the condition of the sources for the resource protection fee and pollution intensity for the pollution fee. On average, the pollution fee is a 0.21 euro tax per unit while the resource protection rate is a 0.52 euro tax per unit. These fees are largely higher than the margins from current tariff, that are around 0.15 euro. Moreover, per-unit margins are higher in rural than urban areas while pollution and resource protection fees are higher in urban areas than in rural areas. Margins are thus not justified by the search for more sustainable use, neither by the scope of struggling against negative externalities.

These fees should be the main instrument to ensure environmental considerations and regulatory rules should incite firms to fix water rates regarding costs rather than sustainable use. These fees could however be reformed in order to be set by progressive tiers matching the marginal private impact of consumption on resource safety, assuming that consuming more water has a more negative impact on resource sustainability. However, the distributional impact would be uncertain as the correlation between consumption and income is positive but very flat. For this reason, agencies could consider regional price

[59]Recently, the price of Antibes, a city in the south of France where water stress is important, has been divided by 1.5.

elasticities and incomes to define the levels of the fees.

A third explanation to current efficiency costs is private operators' participation in the market. Private operators' participation has been growing since the 1980s and is often pointed as being responsible for high marginal prices. On the contrary, public provision is often regarded as an alternative approach for lowering per-unit prices. However, in our OSEA sample, public provision is associated with higher net results than private management, thus leading to higher distortions. There are several reasons for this situation. According to the highest French financial court (Cour des Comptes [2011]), public providers tend to underestimate the depreciation rate of capital in order to get higher net results and to refund their water debt; on contrary, private providers tend to overestimate capital depreciation to decrease their results and the amount that they have to pay in taxes. Moreover, in municipalities with less than 3,000 inhabitants, public managers can use the profits of their water services to finance other prerogatives of the municipality. Finally, public and private management face different tax rates, particularly on labor. Private firms have to pay extra-taxes to fund their retirement schemes; in public management, these fees are paid through taxation at the national level. In the latter case, this means that current lower public management fees are associated with tax distortions in other parts of the economy. In this case, a general rule following Hotelling [1938] could be to directly fund fixed-costs using public subsidies to break the differences in taxation between public and private management.

## 4.6 Discussion and Further Extensions

### To Which Price Do Consumers Respond?

The previous analysis maintains the assumption that households have perfect information and respond to marginal cost pricing, an assumption that is common to several papers, e.g. Saez [2004] on income taxation, Reiss and White [2005] on electricity pricing and Olmstead et al. [2007] on water pricing. These may not be reasonable assumptions. Although water bills are reasonably clear about the distinction between the fixed part tariff and the volumetric charge, many customers have not thought much about the distinction. As a matter of fact, a large number of surveys show that a majority of people do not know the marginal price of their nonlinear tax, electricity and water rates. For example, Carter and Milon [2005] find that only 6% of households know their marginal price of water. Rebalanced prices could then have no clear effects.

Customers who are not aware of the existing two-part tariffs, or that do not understand the two-part tariff, might respond to the total bill, rather than the volumetric charge[60]. Such an assumption would consistently change the previous results as price-elasticities critically depends on whether consumers respond to marginal or average price. Recent empirical evidence on the electricity distribution in the United States shows that customers respond to average price rather than marginal, expected marginal or average price (Ito [2010], Borenstein [2010]). Ito [2010] finds evidence that Californian households respond to average price rather than marginal prices concerning electricity. Although these results are interesting, they do not fit overall water market regulation in France as Californian households face four and five-tier increasing block tariffs. As we have shown in our test of non-linear pricing

[60] de Bartolome [1995] finds for example that many individuals in laboratory experiments use their average tax rate as if it is their marginal tax rate when making economic decisions based on tax tables

schemes in section 2, the structure of rates in the French water industries is simpler and allows households to distinguish average and marginal volumetric prices. However, this leaves interesting studies to do in France in geographic areas where there are two or three-part marginal tariffs.

Borenstein [2010] uses electricity consumption household-level data from Californian utilities and suggests that individuals may use expected marginal price rather than their average price in the presence of uncertainty. Such utility-maximization models can be implemented with annual or monthly series. Our whole dataset contains data for four separate years -1998, 2001, 2004 and 2008 - which makes results less consistent. Indeed, consumers may not choose their level of consumption for a given year using marginal or average prices from their consumption level four years ago.

As a thought exercise, it would be interesting to consider how the welfare implications would change under the alternative hypothesis that households respond to average prices. Under a transition to marginal cost pricing, households with high consumption levels experience decreases in both average and marginal price, implying welfare gains regardless of how well the customer understands the tariff. In contrast, households with low consumption levels could experience decreasing marginal price with increasing average price, potentially moving consumption in the wrong direction. The total change in welfare could be positive or negative.

As an extension, we computed elasticities under average prices. Results are shown in Table 4.9. Price-elasticities when consumers respond to average price varies between -0.606 for the first quintile to -0.581 for the fifth quintile. This leads to a deadweight loss of 9,105,368 euros for 16.7 million households, a higher value than when consumers respond to marginal prices. The reason is that price-elasticities are higher under average price responses. As a result, distributional consequences could be more equitable for poor households under this assumption as the deadweight loss would be higher. Efficiency gains could fund for example 50% of the fixed fees for poor households through water assistance programs. However, the interval of price elasticities suggests increases in consumption that would weaken the achievement of water conservation.

Table 4.9: Price-Elasticity of Demand when Consumers Respond to Average Price

| Variables | Ln(Consumption) |
|---|---|
| Ln(AP) × 1st Quintile | -0.606*** |
| | (0.0294) |
| Ln(AP) × 2nd Quintile | -0.630*** |
| | (0.0292) |
| Ln(AP) × 3rd Quintile | -0.624*** |
| | (0.0284) |
| Ln(AP) × 4th Quintile | -0.608*** |
| | (0.0297) |
| Ln(AP) × 5th Quintile | -0.581*** |
| | (0.0294) |
| Semi-Urban | -0.109*** |
| | (0.0186) |
| Urban | -0.111*** |
| | (0.0175) |
| Household Size | 0.206*** |
| | (0.0290) |
| Touristic Area | 0.121*** |
| | (0.0159) |
| Share of Population 15-64 YO | -0.816*** |
| | (0.139) |
| Region FE | Yes |
| Constant | 5.435*** |
| | (0.0927) |
| Observations | 4,500 |
| R-squared | 0.274 |

Note: Robust Standard Errors in Parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Price-Elasticity is computed for current average prices.

However, one should bear in mind that elasticites computed with average price raise several endogeneity and identification problems as Borenstein [2010] and Ito [2010] noticed. Indeed, as average price depends directly on the level of consumption, the OLS average-price elasticity estimates are probably biased. An instrumented regression should be used, including as instruments consumption shifters that could explain different stable consumption levels. Further extensions, using panel data, would provide consistent demand-elasticity estimates when consumers respond to average price.

Overall, if customers respond to average price rather than marginal price, then the welfare gains from rebalancing water tariffs could be slightly different. This raises other questions such as the design of water bills or transparency about marginal and average prices and about fixed fees and volumetric charges. Because of this lack of information, consumers have probably under-maximizing behaviors. In particular, suggested reforms should be clearly explained to consumers, in order to incite them to change their behaviors in the expected way.

#### Distortions in Connected Markets

A complete empirical investigation of the distortions on connected markets is far beyond the scope of the paper. However, one might consider that sanitation tariffs are also important to consider. Sanitation costs and prices have been growing in recent years for at least two reasons. First, regulation on pollution has been hardened by the need to improve water quality. Second, private participation within this particular sector has been growing because of the large amounts of investments to undertake. Negative net results in sanitation could thus explain the need for margins in water distribution.

Further studies could investigate the global efficiency costs of the water and sanitation markets. As the markets are related, a part of the distortion in one market could be the results from the other market. An interesting question lies particularly in the scope economies that could benefit operators that bundle both public services. Desrieux et al. [2012] for example find strong evidence of scope economies between water and sanitation markets in France leading to reduced bills under bundled services. The study of net results from these two connected markets would be interesting as a part of the investments are shared between the two sectors.

Another connected market is the quality and protection of forest lands. Abildtrup et al. [2011] for example shows using a French sample of cities in France that the proportion of forest land at the local level has a significant negative impact on water production costs. Forest preservation is costly but can lead to the preservation of water resources. Further studies could examine this point, by comparing the marginal cost of protecting forest lands and the marginal impact of this protection on marginal water production costs.

Further studies could focus on the impact of distortions between connected markets. There could be especially some tax distortions between directly and privately managed water utilities that could explain differences in prices and margins at the local level.

## 4.7 Conclusion

In this paper, we used nationally-representative city-level data to characterize the transition to marginal cost pricing in French water industries. The results confirm that price reform would have positive distributional consequences, but tends to be similar from one quintile to another. Needs-based reforms, such as free fixed fees in poor cities, could likely increase the distributional consequences in favor of households at the bottom of the income distribution.

We have three main results. First, we find that departures from marginal cost pricing are not very important - an 8% gap between marginal prices and costs - regarding other regulated industries. However, margins result in a transfer from consumers to producers that results in a 201 million euros gain for operators at the expense of consumers. Second, we compute estimates of the price elasticity of demand that are consistent with previous literature and we estimate the efficiency costs of current rate structure to be around 8 million euros for the French water market for 2008. In short, the current tariffs induce a level of consumption that is too small for a range of households because of inefficient prices. Third, efficient pricing does not level out the existing differences between consumers. Water assistance programs can be implemented to erase the negative impact of marginal cost pricing, especially when fixed fees increase to maintain firms' profits. These programs can be funded by customers themselves through cross-transfers. However, such transfers result in distortions that should not exceed the efficiency gains of marginal cost pricing. Transfers could thus only cover a part of fixed fees for households living in poor cities.

The broader conclusion is that policy makers, firms and municipalities should bear in mind the trade-off between equity and efficiency when implementing rate structures. Stronger regulation in France could lead to the broader use of redistributive tariffs or to the constitution of funds to directly finance households experiencing difficulties to pay their bills. Because of the strong implications of the subject, more analyses, using real world data, are needed to study the impact and the magnitude of rebalanced tariffs and assistance programs.

# Appendix

Figure 4.1: Rebalancing Water Rates

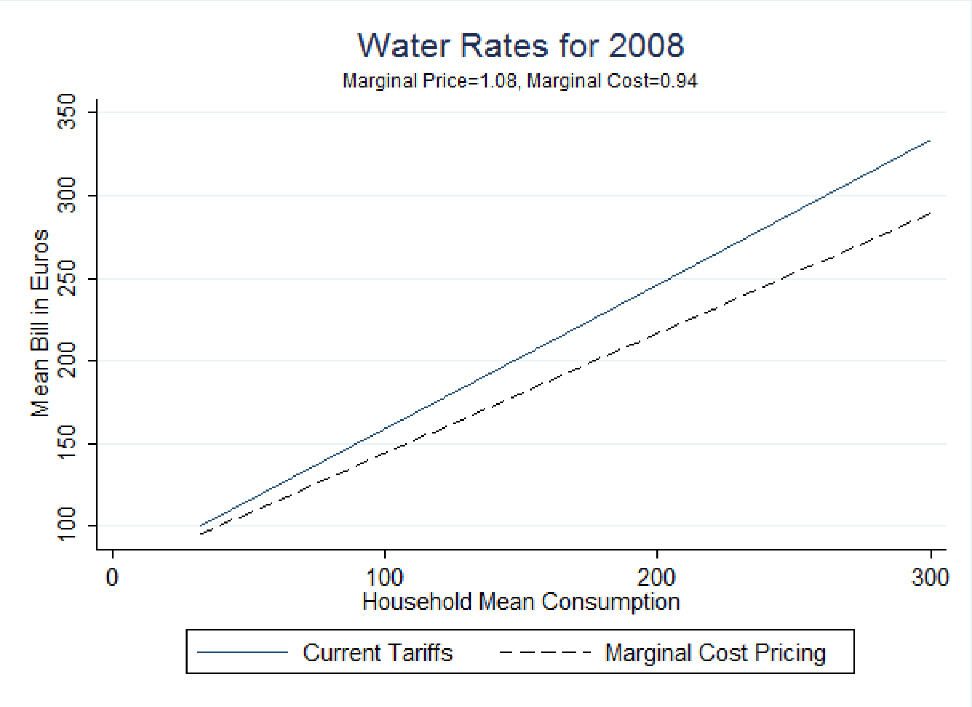


Figure 4.2: Rebalancing Water Rates, by Urban Density and Organizational Type

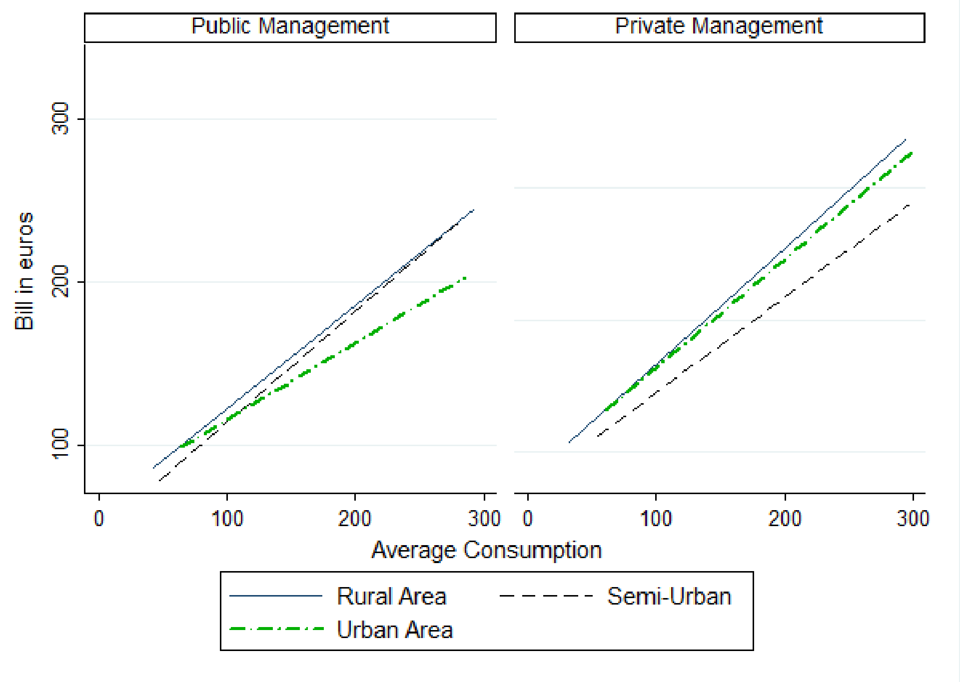



Figure 4.3: Water Consumption and Income

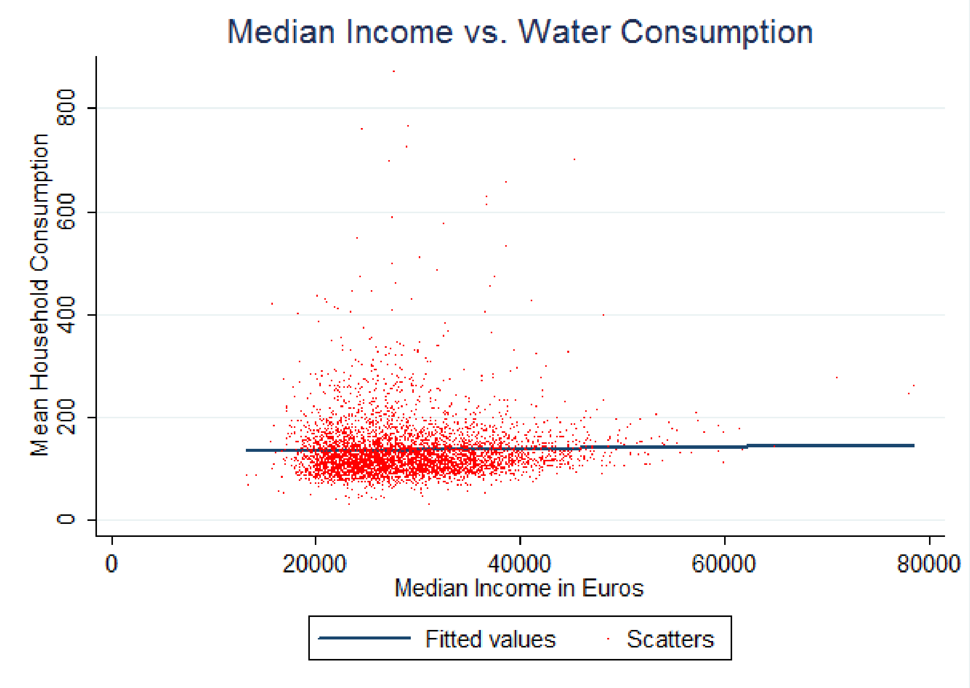
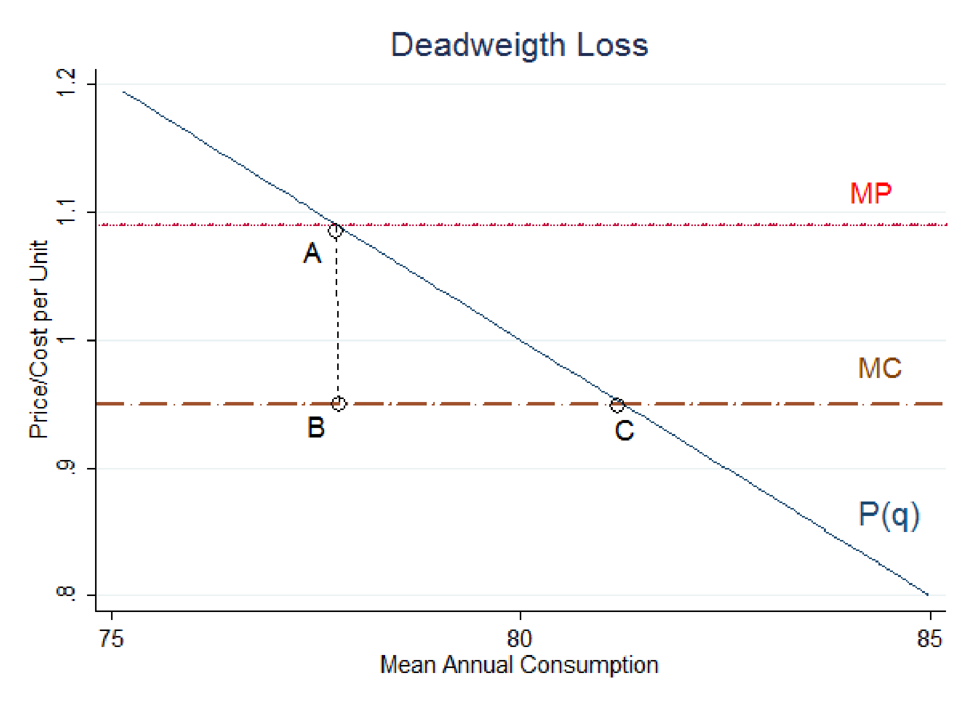


Figure 4.4: The Deadweight Loss from Current Tariffs




Note: The line MC is the constant marginal cost and the line MP is the constant marginal price. P(q) is the inverse Marshallian demand function. The deadweight loss is the ABC region in the graph.

# Summary of Findings and Contributions

In this dissertation we have sought to explore the reasons for and the impact of governance choices in providing public services, in order to elucidate why production units exhibit different strategies and how alternative strategies could lead to different outcomes. In our effort to bridge the standard neoclassical economic background with transaction costs economics, ownership theories, the expense preference theory, the capabilities theory and regulatory economics, we have proposed that different organizational choices can be understood by zooming in on complementary performance indicators engendered by the managers in relation with characteristics of the transaction and of the unit making the outsourcing choice. Particularly, by matching transaction cost economics with the resource based-view of the firm, we have provided empirical evidence on why and how organizational choices impact complementary indicators of performance, and whether these organizational patterns have an effect on global value created at the industry level and in related markets. In the next sections we summarize the main findings and conclusions of the studies reported here, highlight some valuable implications, and provide an overview of the main contributions.

## Summary of Main Findings

Part I of the dissertation focuses on the relation between organizational forms and performance. One of the takeaways of this first part of the dissertation is that organizational forms have rather neutral impacts on performance. The results are somewhat surprising for two reasons. First, advocates of private management may be surprised to learn that our best estimate of the price effects of private management are significantly positive, not negative as it would have been the case if private management was operating in cities that are structurally more difficult. Likewise, we believe that some advocates of more public intervention may be surprised to learn that public management is not associated with substantial price gaps and that neither is more performance. We also think that our results pave the way for further research. First, it seems that the evaluation and the study of organizational changes is in its infancy. Considering that these models are used extensively, a thorough evaluation of their effectiveness needs to be carried out. Second, future research in economics and management could exploit such changes in organization, firm boundaries and ownership to question model interpretation and comparing results using different methods, including structural econometrics. In the first section of the dissertation, we suggested some pathways to stronger methodological design such as the use of reduced samples to comparable observations and the focus on microvalidity. The broader conclusion of the first part is that we need more detailed data to assess the impact of organizational choices on market performance and structure. For public utilities, collecting data on costs and fixed assets could give us a more complete picture of the public-private management comparison. Future research may focus on costs and stakeholders perception as an organizational output.

In the first chapter entitled *Do Markets Reduce Prices?* we focused on the drivers of organizational choices and how these choices impact performance. We empirically test the standard neoclassical hypothesis that markets reduce prices on a large four-year panel of city-leveled data generated by merging IFEN-SOeS with INSEE and complementary indicators from the Ministry of Health. We found that private management is associated with a rather small price premium but with higher water quality and lower levels of public debt. The result is robust when we test the same hypothesis on a reduced matched sample using municipalities with similar characteristics and on municipalities that shift from an organizational form to another. The use of differences-in-differences particularly highlights some patterns in the pricing strategy of privately and directly managed public services. After a switch from public to private management, prices tend to stabilize but they increase in the long run. After a switch from private to public management, prices tend to decrease in the short term but are stable in the long run. Finally, differences in managerial patterns highlight the expense preference of managers. Private managers are more sensitive to quality at high price and low market distortions while public managers give a clear advantage to pricing rather than quality and market distortions. Chapter 1 contributes to the literature on the boundary of the firm and public management(why and what is the impact of organizational choices?), industrial organization (can we use differences-in-differences in industrial organization?) and works in future strategic management (how can we use matching techniques and differences-in-differences to evaluate firms'strategies?).

In chapter 2, entitled *Make or Buy in Water Markets*, we set out to add to the determinants of the boundary of the firm by emphasizing how both transaction hazards and firms capabilities influence change in the organization of the firm, processes and performance. We test our hypotheses on a panel of 4,000 water utilities for four years 1998-2001-2004-2008 using standard econometric methods. This chapter contributes to the literature in several ways. First, our study sheds additional light on the make-or-buy decision. Even if a standard theoretical approach combining transaction costs economics and the resource based-view of the firm is used, our study suggests that an important source of differential capabilities impacting the decision to use the market rather than internal production comes from previous contracting experience in the same domain. Second, previous studies rarely assess how interactions between characteristics can decrease or increase the level of concurrent sourcing. It is important to point that even if transaction costs economics and the resource based-view of the firm are not competing theories of the firm, interactions between their characteristics can show some degree of complementarity between the two. We notably found that capabilities can mitigate transaction hazards. Third, we analyze the impact of the level of make-and-buy on utility performance, which has never been documented in other articles on concurrent sourcing. We particularly found that concurrent sourcing has a significant positive impact on quality performance but results in price premiums, potentially because external procurement demands capabilities to negotiate contracts and to mitigate ex post hazards. The chapter also contributes to the literature on market regulation and externalities. In theory, the development of markets can result in water moving to its highest-valued uses, and the potential gains from water trading have attracted the attention of economists (see Olmstead [2010] for a literature review). While market structure, scarcity and organizational forms can explain why utilities trade water, the usual externalities are rather rarely studied. Our data does not allow us to study in depth the (environmental) externalities of such trades, e.g. on water conservation. We however extensively discuss these problems in the chapter.

The second part of the dissertation questions the technical and allocative efficiency of the industry and the way to promote equity in use. The main findings of this part are twofold. On the one hand, the overall technical and allocative efficiency of the industry is rather high if we compare to similar studies in the water industries in other countries (in Germany for example, Zschille and Walter [2012]) and in other industries (in the U.S. natural gas industry for example, Borenstein and Davis [2011]). Moreover, we assess the performance of public services and their improvement using another indicator such as equity in use. We find that equity in use can be promoted not only by greater efficiency but also by simple rebalanced tariff schemes and the implementation of water assistance programs. We also discuss potential differentiated strategies between public and private operators and their influence on related markets, such as sanitation. Particularly, being aware of the price elasticity of water is largely helpful in designing social tariffs or schemes based on self-funded water assistance programs. These findings are particularly useful for practice.

In the third chapter entitled *Efficiency in the Public and Private Water Utilities: Prospects for Benchmarking* we drew on a technical efficiency perspective used in the context of regulation to assess the relative technical efficiency of 177 large water utilities in France for 2009. We use a mixture of Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) in a three-stage model that enables us to dissociate managerial inefficiencies from the structural inefficiencies and statistical noise. We use net annual revenues as an input variable, standard outputs for production such as the length of pipes, the number of customers and the stock of billed units and an output that accounts for the quality of production, here network performance, i.e. the ratio between billed units and the total volume of water included in the network. Overall, the technical efficiency of the industry is rather high with a score of 0.84 on average. If we compare the relative efficiency of public and private management, we find that public management is associated with a technical efficiency premium of 0.06. We particularly find that directly managed public services have relatively similar performances while those managed by a private operator had more dispersed performance outcomes, despite controls for the potential selection effects. This can be explained by different capabilities of the local authorities to negotiate complex contracts, and thus to reduce transaction costs, and probably in different firm strategies at the local level. This paper contributes to the abundant literature on technical efficiency (how can we control for heterogeneity and selection in DEA models?) and on the literature in public management (when and why can outsourcing be positive?).

In chapter 4, *Efficiency and Equity in Two-Part Tariffs: The Case of Residential Water Rates*, we studied the vital role of tariffs and regulation to promote efficiency and equity in use. We especially study the impact of the implementation of Coasiant tariffs on efficiency gains and their impact on consumers' bill, especially poor households. The chapter is based on a nationally representative dataset of 4,500 French municipalities for 2008. The dataset contains demographic and economic information about households at the municipal level, but also a large set of information on water demand and supply, such as consumption, expenses, rates and some water utilities characteristics. We find that marginal prices differ from marginal costs. Even if the range of the deviation is limited - a 8% deviation is observed on average for the volumetric charge - these markups impose a deadweight loss by leading customers to consume too little water and to support fees that do not represent capital costs. Rebalancing rates to match the Coasian tariffs imply large increase in welfare for consumers, especially those living in cities with lower incomes. This is due to the fact that the correlation between water consumption and income is significantly positive but weak. Consequently, reformed price tariffs benefit more to large consumers than low incomes. Consequently, reformed price tariffs benefit more to large consumers than low incomes. As a matter of fact, after the transition to Coasian tariffs, cities in the lowest fourth quintiles regarding the per-unit income would experience decreases in bills that are almost similar, between 21.45 and 20.07 euros per year. We thus consider alternative water assistance programs focusing directly on cities with lower per-unit incomes. We find that a free fixed fee policy could be implemented for poor cities, without loss of profits for firms, at the cost of 1.90 euros per non recipient of the assistance program. We then compare the costs of these assistance policies to the current efficiency costs. Under conservative levels of price elasticity, a transition to marginal cost pricing implies efficiency gains of 8 million euros in 2008, a level that is low compared to the global profits of water industries in France. However, these efficiency gains are sufficient to fund assistance programs such as decreased fixed fees for poor households. The chapter finally highlights several explanations for the current price distortion, such as firms profit maximization (small versus big consumers?), resource scarcity (markup versus Pigouvian taxes?) and management structure (public versus private?). We then briefly discuss the validity of the results, precisely regarding the consumers' responses to marginal prices and the link with related markets, such as sanitation. This study contributes to the literature on public utilities' regulation (what are the efficiency costs from current regulation and how can we promote equity in use?), consumer behavior (do consumers respond to marginal or average price?) and social policies (can we use market mechanisms to subsidize the bottom of the pyramid?).

There are strong linkages between the questions raised in Part I and Part II. Chapter 1 questions the market structure of public services. One of the questions that is broached is the link between greater competition and greater performance. The main result suggests that rivalry can realign prices at their "real" level, such that they cover costs without abnormal margins. We discuss in detail the margins controversy in Part II. In chapter 2, we study the organization of public services at two levels, the lease-manage decision involving the public service and the city and the produce-buy decision involving different cities. Even if we focus on the decision and the impact on complementary performance indicators of water trades between municipalities, we discuss several regulatory implications of water trades between municipalities. Theoretically, water trades should increase the allocative efficiency of the market and benefit to cities with poor access to water. The question of the access to water for municipalities with scarce resources is largely connected to the overall equity concerns of fairness in pricing. By the same token, we discuss technical efficiency comparisons between publicly and privately managed utilities in chapter 3 regarding the results in chapter 1. Even if the samples are different, results are quite similar, which confirms rather small but nonetheless significant differences in performance between public and private management. In chapter 4, we also discuss the essential differences between the public and private management of public services, and particularly on the determinants of their pricing strategies, a discussion that is highly related to chapter 1. A summary of research questions, main findings and overall conclusion is presented in Tables 4.10 and 4.11.

This dissertation has several limitations. Firstly, we have not completely explored links between organizational forms and some indicators of political competition. Even if we could compute some political indicators for a subsample of public services, the estimations do not show any statistically significant impact on organizational choices. We lack some more detailed analyses on political competition and city-leveled monitoring costs to have a clear assessment of cities' capabilities. Secondly, a complete longitudinal dataset could give us a more detailed picture of the impact of private sector participation on prices and quality indicators. Thirdly, it is not possible to have access to contracts to study the impact of the design of contracts on performance which is an important implication for the value created by the industry. Finally, the dissertation lacks corporate social responsibility to be conclusive on the relative performance of private and public management in resource conservation. As most of these indicators have been implemented in 2005 and are consequently rarely achieved in 2008 and 2009, further data building could improve these variables that can explain presently observed performance differences between utilities.

Table 4.10: Summary of Main Findings

| Research Question | Findings | Conclusion |
| --- | --- | --- |
| • **Chapter 1**: Do Markets Reduce Prices?<br>• **Research Questions**: What are the reasons for and the impact of organizational choices on performance? Why do organizational forms lead to different outcomes? | • Complexity and contracting capabilities are inputs for organizational choices.<br>• Using complementary indicators of performance show rather small but significant differences in performance.<br>• Switching from public to private management increases prices after several years, not in the short-run; switching from private to public management decreases prices in the first years, not in the long-run.<br>• Public and private managers may have differentiated preferences. | • The use of standard econometric methods, matching methods and natural experiments such as organizational change shows a rather small difference in performance between public and private management. The relative performance in complementary outcomes underlines managers' expense preference. |
| • **Chapter 2**: Make or Buy in Water Markets<br>• **Research Questions**: What are the reasons for and the impact of concurrent sourcing? | • Transaction costs and capabilities are inputs for the decision to both make and buy the same good.<br>• Asset specificity mitigates the impact of contracting capabilities on concurrent sourcing.<br>• Concurrent sourcing occurs when volume uncertainty is predictable to ensure service continuity.<br>• Concurrent sourcing leads to a price premium that is comparable to an insurance premium, and to transaction costs. | • Firm boundaries cannot be summarized by corner solutions and are best explained by a mixture of transaction costs economics and the resource based-view of the firm. Such capabilities are useful to explain the overall impact of the make and buy decision on performance. |

Table 4.11: Summary of Main Findings (cont'd)

| Research Question | Findings | Conclusion |
|---|---|---|
| • **Chapter 3**: Efficiency in the Public and Private Water Utilities: Prospects for Benchmarking<br>• **Research Questions**: What is the overall technical efficiency of French water suppliers? Is there an efficiency gap between public and private management when we control for structural differences? | • The overall technical efficiency is 0.84 and the gap between public and private management is low, around 6%.<br>• Structural differences explain half of the gap found in the first stage.<br>• Technical efficiency does not appear to be linked to the size of the decision making units. | • Private management has more dispersed technical efficiency because of the differences in transaction costs and firm capabilities to mitigate ex post hazards. |
| • **Chapter 4**: Efficiency and Equity in Two-Part Tariffs: the Case of Residential Water Rates<br>• **Research Questions**: How do marginal prices differ from marginal costs? What are the distributional impacts of a switch from current tariffs to Coasian tariffs? Do the reformed tariffs better fit the equity considerations? What are the efficiency costs from the observed deviations from marginal cost pricing? | • There is a 8% deviation from marginal cost pricing.<br>• Rebalancing prices to match the Coasian tariffs imply a large increased welfare, between 21.45 and 20.07 euros per year out of an average bill of 190 euros.<br>• The distributional impact of the Coasian tariffs is however low, compared to well-designed water assistance programs.<br>• The overall deadweight loss for the national industry in 2008 is rather low, around 8 millions euros, but sufficient to fund (a part of) assistance programs. | • It is possible to promote efficiency and equity in use by rebalancing tariffs and implementing self-funded water assistance programs. |

## Implications for Research in Public Management

A clear implication of our research is that contrary to public management studies which mainly focus on bureaucracies, we study a sector that is largely liberalized to private sector participation and that is businesslike whatever the procurement modes (we discuss in the introduction the interest to study organizational choices in the water supply industry). A particularly interesting feature of our research is that it studies an environment in which public and private management are competitors and use different managerial practices to achieve different outcomes.

A vast literature in public management and organization theory tries to measure how public and private organizations differ from one another in their internal administrative practice and in their values and motivations (Boyne [2002], Perry and Rainey [1988] for example). In chapters 1 and 3, we particularly insist on the expense preference of managers theory developed by Williamson [1963]. This theory insists on managerial discretion in daily business behavior. Although the original framework proposed by Williamson is designed to give a theoretical explanation of the use of discretionary resources by managers, it has a clear echo in the public management literature. To the extent that the managers' objectives are also discretionary, private managers will privilege quality and impermeability of accounts rather than affordability, while public managers - perhaps due to the influence of political authorities - tend to advantage affordability rather than quality and non-permeability of accounts. Contrary to the public choice or the soft budget constraint, this theoretical background does not inherently link public management with a lack of efficiency and accountability in spending.

Another part of the literature on public management has tried to come up with a clearer identification of a range of managerial competencies required to effectively manage contracts (Brown and Potoski [2003] and Kettl [1993]). The idea is that the tasks required to manage contracts are unique and demand special management capacities, even in the case of outsourcing. There are usually two accounts for government outsourcing decisions. One view focuses on transaction costs and looks at the lease-manage decision by analogy to the make or buy decision (Williamson [1985]). In this account, outsourcing is dictated by efficiency considerations. An alternative view, advanced by Boycko et al. [1996] among others, builds on the public choice theory and emphasizes the private benefits politicians enjoy when keeping service provision inside the government. In this case, outsourcing tends to occur only in response to external pressure, tight budgets for example. This view of the lease-manage decision usually leads to three propositions. First, complexity in service provision leads to the writing of more complex contracts and potentially to higher transaction costs in enforcing ex post negotiations. Complexity should then have a negative impact on the outsourcing decision. Second, asset specificity can be measured by the volume of specific investments or simply by the length of the relations where long-term contracts create by definition specificity in investments and in the relationship between the two parties. Third, public managers have different preferences and thus patterns of outsourcing decisions that we should control for. In this thesis, we defend that the lease-manage decision can simply be explained by transaction costs economics and the resource based-view (Wernerfelt [1984]) of the municipality. We simply assume that large municipalities and municipalities with experience in contracting out similar public services tend to outsource the public service. This tendency is however mitigated by transaction hazards. The result holds for the lease-manage decision of the public service and for the produce-buy decision of water at the utility-level. The result does not mean that politicians do not search for the maximization of their utility but that they consider their capabilities and the nature of the transaction in make-or-buy decisions.

Finally, while the new public management theory assumes that contracting out can enhance the efficiency of public services, it does not fundamentally address the conflict between efficiency and equity, even though equity is the criterion of performance that may be regarded as uniquely relevant to public services (Moore [1995], Boyne [2003]). While we study the performance and the efficiency of outsourcing the provision of water in the whole thesis, we particularly focus on the potential trade-off between allocative efficiency and equity in chapter 4. We conclude to the possibility of designing prices that serve the efficiency of the industry and the equity in use for households. We particularly underline that efficiency gains can be used to fund a part of water assistance program, at least to cover the administrative costs of the implementation of an agency funding these programs. Such a debate on equity in use is in current debates on organizational choices. Of course equity should not come at the expense of efficiency gains.

## Implications for Research in the Organization of the Firm

Our theorizing has drawn on the idea that transaction costs and capabilities are complementary on multilevel make-or-buy decisions. Our interpretation is that cities with prior experience in designing and operating complex and incomplete contracts may find such contracts less costly to write, be more skilled at enforcing their requirements and be more accustomed to ex post adaptation. In chapter 1, contracting experience can be a reason to lease the water public service and we find that endogeneizing the organizational choice by the contracting capabilities can diminish the price premium in privately managed utilities. This contracting experience has a substantial and significant effect on organizational choices. However, because the level of specific investments differs from a city to another, this contracting experience has a declining effect when hold-up risks are more important. It means that the "make or buy" dilemma should not only be focused on transactions but also on firms and their capabilities which may evolve over time. These capabilities can give a competitive advantage to a given city for producing the service, but also in the diverse sets of tasks such as deciding whether to contract for a particular service, establishing and implementing a process for outsourcing the service, and managing the delivery of the service once a vendor has been selected.

Moreover, the standard governance costs approach developed by Coase [1937] does not account for volume exchanges in the markets but predicts corner solutions for the organization of the firm. In chapter 2, we study the possibility of non-corner solutions for the organization of the firm, a practice that we named "concurrent sourcing", i.e. the possibility for each city of buying and making the same good. In the standard strategic literature (Adelman [1949], Porter [1980] and Williamson [1985]), vertical integration occurs for two reasons. For Adelman [1949], firms concurrently source in times of demand uncertainty, pushing the fluctuations in volume onto suppliers in order to ensure full internal capacity and stable production. Porter [1980] has a similar view but adds that firms concurrently source to gain an increased understanding of the production process. The inversed view is shared by some economists, such as Lucas [1978] who believes that managerial talent is a scarce resource that can be leveraged by creating hierarchical organizations and Arrow [1975] who considers a model in which information can be transmitted within an integrated firm but not between disintegrated firms. Unlike the former authors, Williamson [1985] argues that the organization of the firm is only a response to specificity being defined as the gap between the value of the ongoing relationship and the value of the parties' outside alternatives. Inputs or relationship with the same specificity should then be organized in the same way. Under transaction costs economics, the decision to make and buy the same good is not straightforward, and cannot be duplicated to different strategical decisions within the same unit of production.

The ideas developed in transaction costs economics, capabilities theories and decision-right theories have been the starting point of a long series of empirical studies dating back at least to Monteverde and Teece [1982], Masten [1984] and Joskow [1985] and others (see Shelanski and Klein [1995] and Bresnahan and Levin [2012] for literature reviews). The typical strategy in the empirical literature has been to relate observed organizational choices to measures of contractual frictions, or more often proxies for these frictions. In a very few cases, an attempt is made to link the organizational choices to economic outcomes such as costs, prices, quality, productivity or innovation. The same critic can be addressed to research on the resource-based view of the firm (Poppo and Zenger [1998]). Part I of the dissertation matches the two theoretical backgrounds and finds that transaction costs economics and the resource based-view are complementary theoretical backgrounds which may explain the boundary decisions of the firm.

In chapters 1 and 2, we relate organizational choices to measures of economic performance such as pricing and quality. In chapter 1, we find that organizational choices have a statistically significant impact on the price for a standard bill, but also on water quality and the level of the public debt related to the water infrastructure. Focusing on municipalities that changed organization between 1998 and 2008, we observe similar results; organizational change affects performance but the effect is temporary. Chapter 1 discusses the decision-rights theory as a basis to differentiated public and private performance and proposes an alternative explanation based on managers' expense preferences.

In chapter 2, we discuss the impact of organizational choices not for the vertical organization of the public service but at the production level. In this context, utilities trade water between one and another, depending on their production capabilities for example. As a result, they can solely make or make and buy the output to be sold. We find that utilities that make and buy rather than only make are characterized with lower performance, relative to utilities that only make. Even if the comparison is based on cross-sectional analyses, results show that the make-and-buy decision is rather related to capabilities rather than the research for a strategic competitive advantage.

In chapter 3, the methodology does not allow us to properly correct for the endogeneity of the organizational choice but we control for differences in the operating environment of private and public managers. Even if some studies control for the differences in organizational form (see Zschille and Walter [2012] for example), it would have distorted our technical efficiency scores by giving a clear advantage to one of the organizational forms. We find a differentiated technical efficiency between public and private management. Direct management exhibits an average technical efficiency of 0.88 versus 0.82 for private management. This gap is lower than the difference in taxation in favor of publicly held utilities (see Boston Consulting Group [2007]). The broader conclusion from this article is that the overall technical efficiency of the industry is rather high and that organizational choices have significant but limited impact on overall technical efficiency.

Chapter 4 finally questions whether the organization of public services can impact the overall efficiency of the water provision industry. In this case, the question of the organization is used to estimate whether prices fit costs. The chapter especially raises the question of account permeability, something that is possible when the water public service is legally or not directly funded by the local authorities. In this case, price can be disconnected from costs and taxes can be used to fund the water public service or the other way round. This raises a question on whether taxes or tariffs are less distortive for the economy which is in the background of the public-private management debate. Even if the organizational choices are quite neutral on the overall allocative efficiency of the industry, they can have strong impact of related markets, such as debt or sanitation.

## Implications for Research in Regulatory Economics

Regulation of public utilities has been debated extensively in the past twenty years, especially in Europe where deregulation has been considered as an input to the macroeconomic policy. As competition in the market is precluded due to the natural monopolistic characteristic, competitive solutions that could promote efficiency can be implemented. Three such solutions are franchise bidding mechanisms, yardstick competition and alignment between prices and costs. Franchise bidding mechanisms as a way to introduce competition into industries where market competition is precluded was suggested by Chadwick [1859] and popularized later by Demsetz [1968]. This mechanism is the traditional auction process organized by a public authority to attribute temporary monopolistic market rights to private firms via a contractual arrangement between the public entity and a private firm. This competitive process is supposed to be beneficial in terms of limiting market power conferred by such contracts unto the chosen private operator.

In chapter 1, we empirically test the impact of competition for the market on prices. Regional or sector-level competition is a usual argument to explain differences in prices between public and private management (Joskow [2005]): high margins are the result of low competition intensity which has to do with the nature of the market, i.e. local monopolies protected by a contract. When it is difficult to promote competition in the market as in water provision, margins are highly related to the ability of the municipality to negotiate with the private operator. Moreover, pricing strategies are usually based on previous prices for at least two reasons: first, because prices are fixed to cover previous costs, whether there is room for cost-efficiency or not, and second because a given level of prices gives the quantity at which market clears. One of the reasons why private management has higher prices is that contract renewals are based on previous prices and thereby maintain the price gap between public and private management. An increased competition when the contract renewal occurs generally lowers prices. In France, Guérin-Schneider and Lorrain [2003] examined contract renewals between 1998 and 2001 and found that renewals were usually associated with decreasing prices (-10% on average). The results also suggest that prices are set too high, as a result of extra-margins before renewals or inefficient cost structures. As we neither have information on bids nor on geographical competition in our dataset, we use incumbent renewals as a proxy for competition. In natural monopolies such as water provision, ill-equipped regulation can have negative impact on consumers (Coase [1946]) or can be associated with a low-monitoring efficiency of the principal (Laffont and Tirole [1993]). The magnitude of the renewal is significant between -8 and 3.8 euros while the operator change is between -9 and -24 euros. We explain the potential decrease in price after the renewal as a realignment of price from the previous long-term contract.

In chapter 2, we briefly discuss some further implications on the regulation of water trades between utilities. It is unfortunately impossible to have detailed data on the identity of municipalities buying and selling water. Nevertheless, observations on a subsample of 62 large utilities does not confirm suspicions that water trades occur essentially in-between utilities managed by the same firm. We particularly discuss the rather negative impact of concurrent sourcing on performance, something that we interpret as being linked to the scale effect: local authorities which relatively buy a lot of water are usually small and rural. Even if the article focuses mainly on the determinants of the organizational form of trades between cities, further economic evidence including a measure of allocative efficiency, potential externalities and third-party effects could be studied using more detailed data. We however question these factors from a regulatory point of view.

Chapter 3 uses benchmarking methods to analyze technical efficiency in terms of realized deviations from an idealized frontier isoquant. The intellectual basis of benchmarking models comes from Farrell [1957] that redirects attention from the production function specifically to the deviations from that function. These benchmarking techniques have been widely applied in real-life regulation in order to implement yardstick competition. Yardstick competition, first proposed by Shleifer [1985], is a regulatory tool under which a private operator's financial outcome depends on its relative performance vis-à-vis that of its reference group. Even if we cannot test the impact of the implementation of yardstick competition on future performance, we used Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA), two standard regulatory tools, to evaluate the relative technical efficiency of 177 local public services for 2009. Results have already been depicted above: private management is technically less efficient on average, due to a higher level of dispersion of performance indicators. The implementation of yardstick competition could give differentiated targets to increase the overall efficiency of the industry. The results are similar and complementary to those of chapter 1.

Chapter 4 contributes to the literature on public utility regulation in several ways. First, it shows that contrary to other regulated industries, water supply in France has low-margins. However, deviations from marginal cost can have strong welfare and distributional impacts. The reasons for this marginal cost deviations such as revenue and consumption volatility are debated in the chapter. Second, several assistance policies are empirically tested and it is shown that at low-cost for water suppliers, it is possible to fund some assistance programs. These assistance programs have stronger distributional consequences than tariff reforms. Third, the chapter questions the impact of two-part tariffs on consumers' behavior, especially whether consumers respond to average or marginal price. Fourth, it shows that efficiency gains, which have been studied extensively (Hotelling [1938], Coase [1946] and Baumol and Bradford [1970]), can be reached with marginal prices set to marginal costs and fixed fees equal to each customers' share of fixed costs. However, the efficiency gains are rather low but could be used to cover a part of poor households' fixed-fees, and thus promote equity in use. This result bears several important implications for two-part tariff regulation in regulated industries.

## Implications for Managers

Our research carries several implications for the political authority and for public managers' strategy. Debates about the relative technical efficiency of private and public management frequently arise. In France for example, in 2009, a year after the municipal elections, the left-wing mayor of Paris decided not to renew the city's water provision contract with two private operators and to directly manage the public service. The municipality is now in charge of providing water for the 2 million inhabitants of the city. In the beginning of 2011, after a year of direct public management, the mayor announced that good performances will lead to a decrease by 8% of the drinking water price in Paris from July 2011 onwards. Consequently, other French public authorities decided to directly provide water to their users without contracting out with private operators arguing that public management is more efficient for managing public services. Even if public management is found to be more efficient in the first part of our dissertation, several implications should be taken into account. First, municipalities must be aware that switching from a management form to another will impact their prices, but not in the proportion they expect. Structural reasons are probably more robust at explaining prices than organizational choice itself. Second, comparing municipalities between themselves imposes a reasonably similar sample in terms of observables. Third, switching is costly. It requires strong organizational capabilities on the part of public managers as well as considerable financial resources to buy some fixed assets to the former operator. Moreover, price is not the only performance indicator that public managers should take into account when they decide to revert back to direct management. Water account debt and water quality are two complementary performance indicators that should be taken into consideration. The excessive focus on price probably gives wrong incentives to managers that are willing to improve public service efficiency.

One of the implications for practice of the dissertation is that managers must be aware of their capabilities and the nature of the transaction. In Part I, we discuss the reasons for the lease-manage decision and for the make-and-buy decision, two different transactions on the same good. We conclude in both chapters that when considering their sourcing options, public managers should be aware of their capabilities to mitigate hazards such as ex post renegotiation at the local level. We believe that being aware of their capabilities and of the nature of the transaction, public managers will avoid misalignment in selecting their governance choice. It seems clear that aligned governance choices yield a competitive advantage. Yet, private and public managers must be aware that utilities and cities need to have a thorough understanding of their capabilities in order to undertake long-term contracting or concurrent sourcing. Such characteristics should be taken into account to enhance organizational performance.

Chapter 2 studies intercity trades, a subject that has received little interest in the literature. More evidence on the impact of making and buying in performance is important for managers and citizens. Managers need more guidance about whether to contract for particular services and what capacities are needed to effectively manage contracts. It also directly questions the need for larger services that can take advantage from scale economies. For example, the Cour de Cassation (November, 7th, 2005), the highest judicial court in France, confirmed the judgment of the competition authority in France that fined two operators that distorted competition on local water trades. Being aware of the competitive environment in which managers find themselves is a question that deserves more attention. Also, environmental and social externalities from water trades should be taken into consideration when cities contract for trading water.

The dissertation also raises several regulatory implications. In long-term contracting, the implementation of yardstick competition can be a way to increase the competitive pressure on firms' and give incentives for laggard firms to increase efficiency. In the first chapter, we found that renewals or organizational change can lead to a decrease in retail prices. The problem for managers is that if they are unable to mitigate ex post opportunism, they can only expect competition at the renewal to realign prices. In this case, the implementation of yardstick competition can be a way to increase the competitive pressure on firms' and give incentives for laggard firms to increase efficiency. Private managers can subscribe to this view too as recent renewals question their margins and their ability to reduce costs. The recent case of Antibes, a city in the south of France, is probably one of the best examples. In 2012, contract renewal with the same operator led to a 40% decrease in the standard bill for the average household. A private competitor bade at a 30% lower price while the city was ready to revert back and diminish price by more than 30%. For public managers, it is then difficult to credibly think that the previous contract was cost-efficient while private managers have to face the lack of confidence of public managers. Benchmarking tools could at least give some targets for technical efficiency and judge managers' performance on their capacity to get closer to the efficiency frontier. They give information to managers on their cost structure and on how they can contain their costs.

Furthermore, a national debate has been launched on how public utilities rate structure can promote efficiency and equity in use. Current government projects, based on two or three-tier rate systems depending on the level of consumption, are far from being economically efficient and have potentially negative effects on large households' bills. In chapter 4, we believe that policy makers, firms and municipalities should bear in mind the trade-off between equity and efficiency when implementing rate structures. Stronger regulation in France could lead to the broader use of redistributive tariffs or to the constitution of funds to directly finance households experiencing difficulties to pay their bills. Because of the strong implications of the subject, more analyses, using real world data, are needed to study the impact and the magnitude of rebalanced tariffs and assistance programs. Public and private managers need to better understand whether consumers respond to marginal or average price and how they would react to different price structures. Better policy design and evaluation can be achieved by a better understanding of consuming patterns. Particularly, being aware of the price elasticity of water is largely helpful in designing social tariffs or schemes based on self-funded water assistance programs. Recently, Dunkerque, a northern city of France has passed a contract with Lyonnaise des Eaux based on two-part marginal prices and differentiated fees for consumers that can afford water in order to fund some water assistance programs for the poor. Moreover, better transparency for consumers on how much they consume and the price they pay is an important goal to better understand consumer behavior. Managers should develop such capabilities in decision-making as a strategic advantage.

Finally, the broader conclusion of the dissertation is that it is fundamental for policymakers, public and private managers to keep in mind that there is a real trade-off between efficiency and equity when implementing rate structures. Policymakers need to understand that influencing prices to accomplish distributional goals can have important efficiency costs that they do not see as "real" costs. In our opinion, optimal tariff design should be separate from redistribution that is better endorsed by taxation or water assistance programs. Finding the "fine tunning" between efficiency and equity is perhaps the biggest challenge faced by regulators and managers.

## Avenues for Future Researches

The research developed in this thesis raised several organizational, regulatory and equity questions. Further research could focus on stakeholders' perception of water utilities measured by political activism or stock performance and on corporate social responsibility as a performance indicator. The collection of various datasets during this dissertation gives us little but valuable information on the reasons and frequency of contract renegotiations, indicators approximating knowledge of the network and environmental performance of the network. Moreover, a complete overview of the water industry includes detailed information on sanitation public services. Such a collection of indicators has been done for "bundled" public services whenever it was possible but the information on utilities that do not use the same operators for the two public services still need to be collected. Collecting detailed data on these variables would lead to noteworthy research on water and sanitation.

Methodologies used in this dissertation can be extended to further research in economics and management. We believe that research in management could use more matching methods and differences-in-differences to assess the impact of a policy or an exogenous change on performance. Such issues have been largely debated in two workshops on contracting ("A variety of theoretical approaches to address contractual issues: complementarities and overlaps" and "Using experiments to examine infermirm exchanges") and a workshop on organization ("The Dyad in context: developing and managing a system of vertical partnerships") at the latest Academy of Management Conference that was hold in Boston, MA in august, 3-7th.

Theoretically, research in (public) management should integrate two aspects that are extensively discussed in this dissertation. The first one is equity as a measure of performance. The need to include equity and access is for example underlined in Prahalad and Hart [2002] that insist on the "bottom of the pyramid" as an opportunity for firms seeking fortune. Firm strategy regarding equity should be theoretically and conceptually clarified. The second theoretical aspect that should be deepened is how to complete our knowledge of firm boundaries by using theoretical frameworks that do not use dyads to explain vertical and horizontal integration. We believe that these two theoretical questions should be addressed in future research in management.

Finally, even if the results of this dissertation are based on a study of French water utilities, they are valuable for research in economics and management in other regulated industries such as electricity, natural gas, telecommunications and wireless broadband and in other public services such as waste management or school meals. Especially, the idea that managers follow differentiated goals and that organizational choices are quite neutral on performance when one considers complementary indicators could be tested using data from other sectors.

## Summary of the Implications for Research in Economics and Management

The following Tables 4.12 and 4.13 provide an overview of the main contributions of each study to the individual elements of the proposed framework.

Table 4.12: Summary of Main Contributions for Research in Public Management, Firms' Organization and Regulated Industries

| | **Public Management** | **Firms' Organization** | **Regulated Industries** |
|---|---|---|---|
| • **Chapter 1**: Do Markets Reduce Prices? | • The results shed light on the expense preference of public and private managers.<br>• Contrary to new public management, increased private sector participation does not foster large efficiency gains.<br>• Beyond a preference of managers for contracting out, capabilities and complexity explain the reasons for contracting out.<br>• The increase in competition in public services does not always increase performance. | • Organizational choices depend on transaction hazards and capabilities to mitigate these hazards.<br>• Organizational choices can have a neutral impact on performance.<br>• Organizational change does not lead to very different (and always immediate) performance outcomes. | • Periodical bidding is a priori a good means to realign retail prices.<br>• Long-term contracting fosters relative low change in organizational forms.<br>• No clear results in the sense of an organizational form or another that should be encouraged. |
| • **Chapter 2**: Make or Buy in Water Market | • Local authorities have differentiated capabilities to negotiate contracts and heterogeneous production capabilities.<br>• The make and buy decision responds to some strategic objectives.<br>• The make and buy decision is associated with lower performance. | • Transaction hazards and capabilities can explain why firms both make and buy the same good.<br>• Transaction hazards mitigate the impact of capabilities on organizational choices.<br>• The make and buy decision at the utility-level also helps explain the lease-manage decision of the public service. | • Water trades raise several regulatory questions that remain largely unstudied such as allocative efficiency and externalities of intercity trades.<br>• Regulatory indicators of scarcity and cross-cities consumption intensity could be implemented. |

Table 4.13: Summary of Main Contributions for Research in Public Management, Firms' Organization and Regulated Industries (cont'd)

| | **Public Management** | **Firms' Organization** | **Regulated Industries** |
|---|---|---|---|
| • **Chapter 3**: Efficiency in the Public and Private Water Utilities: Prospects for Benchmarking | • Contracting with private firms is not necessarily the way to improve public service efficiency.<br>• Large cities that have necessarily separated account for water seems to overperform when management is public.<br>• There is an ambiguous performance of private firms managing the public service. | • Beyond the size of the organization, the structural environment and the capabilities of the managers matter to explain the relative performance of organizational forms.<br>• Private management's technical efficiency scores are more dispersed. | • Benchmarking methods give similar conclusion than standard econometric methods.<br>• Highly dispersed scores for private management can be the result of differences in transaction costs as cities differ in their capabilities to implement complex contracts.<br>• In long-term contracts, yardstick competition is particularly useful to foster internal competition in an industry. |
| • **Chapter 4**: Efficiency and Equity in Two-Part Tariffs: the Case of Residential Water Rates | • Public policies can be implemented to increase efficiency and equity in use.<br>• Tariff design could take into account consumers' price elasticity. | • Organizational choices are quite neutral regarding the potential efficiency gains of the industry.<br>• Organizational choices can have a strong impact on pricing in related markets such as sanitation, taxes or debt. | • Marginal price significantly differ from marginal cost.<br>• Rebalanced tariffs benefit to all consumers in a rather similar way.<br>• Promoting equity through water assistance programs has a greater impact for poor households.<br>• Overall efficiency gains are small but can fund a part of water assistance programs. |

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# Résumé Détaillé en Français

La présente thèse de doctorat étudie des liens existant entre les choix organisationnels et leur performance relative dans le service public de l'eau en France. Si ce travail de recherche est essentiellement empirique, il contribue néanmoins à la littérature théorique sur l'organisation de la firme et sur la régulation des services publics. La thèse de doctorat est divisée en deux parties. Dans la première partie, nous nous intéressons aux choix organisationnels des municipalités et à leur impact sur la performance du service public de l'eau. Ainsi, les choix organisationnels sont ici endogènes. La deuxième partie considère les choix organisationnels comme étant exogènes et évalue l'efficience technique et allocative de l'industrie. L'efficience technique correspond à la minimisation des inputs pour atteindre un niveau de production donné. L'efficience allocative correspond à une situation dans laquelle aucun changement n'est possible pour améliorer le bien-être d'un individu sans détériorer celui d'un autre individu. Nous avons alors recours à des outils de régulation pour proposer des réformes permettant d'augmenter l'efficience du secteur dans son ensemble. A titre d'exemple, nous proposons plusieurs réformes tarifaires qui peuvent favoriser l'efficience économique et l'équité dans l'accès à l'eau.

Les deux parties de la thèse se décomposent en un sous-ensemble de questions. Premièrement, quelles sont les motivations des choix organisationnels et leur impact sur la performance ? Deuxièmement, pourquoi les municipalités ont-elles recours à leurs propres ressources d'eau et à des ressources importées pour assurer la provision du service public de l'eau ? Troisièmement, quelle est l'efficience technique de l'industrie et existe-t-il des différences entre formes organisationnelles ? En dernier lieu, peut-on promouvoir l'efficacité économique et l'équité dans la consommation d'eau résidentielle en France ? La thèse est organisée sous la forme de quatre essais, dont les questions de recherche sont liées mais qui peuvent être lus séparément, chacun des chapitres ayant étant consacré à un ensemble de questions spécifiques soulevées ci-dessus.

Nos recherches portent sur le secteur de l'eau en France. La France est un des pays pionniers de la participation du secteur privé pour la provision des services publics. Depuis les années 1980, les contraintes budgétaires qui pèsent sur les autorités publiques locales et les gains d'efficience attendus de la participation du secteur privé ont accéléré la tendance à la délégation des services publics. Aujourd'hui, en France, la gestion de la plupart des services publics d'eau et d'assainissement, mais aussi la gestion de la majorité des cantines scolaires par exemple, sont actuellement délégués à des entreprises privées. Il n'est pas toujours facile de trouver le bon arrangement entre acteurs publics et privés. Les manageurs public et privé doivent négocier le contenu du contrat, gérer les litiges qui peuvent survenir pendant le partenariat, éviter les distorsions qui peuvent se produire sur les marchés et promouvoir l'accès et la continuité du service. Dans les services publics, la participation du secteur privé et la nature parfois monopolistique de ces services posent plusieurs questions telles que la performance relative des secteurs public et privé et comment les différentes formes d'organisation peuvent favoriser l'efficacité et l'équité dans l'emploi.

Une étude empirique du service public de l'eau en France est particulièrement intéressante pour plusieurs raisons. En premier lieu, le marché de la distribution de l'eau couvre l'ensemble de la population française ; les choix organisationnels peuvent donc avoir des conséquences économiques importantes pour les ménages. Deuxièmement, la participation du secteur privé a augmenté depuis les années 1980, les entreprises privées gèrent actuellement plus de 60% des services publics d'eau. Une comparaison de la gestion publique et privée est donc possible. Par ailleurs, il n'existe pas de marchés secondaires qui peuvent atténuer l'impact de la participation du secteur privé comme c'est le cas dans les télécommunications ou l'accès à Internet sans fil. Enfin, la décision de faire ou de "faire faire" reçoit depuis plusieurs années une attention politique et médiatique considérable. De grandes villes comme Paris ont récemment décidé de revenir en gestion directe.

Dans le service public de l'eau, le réseau qui permet d'acheminer l'eau de l'usine aux usagers est la propriété de la collectivité publique. Seul le service public peut être délégué à la gestion privée. Il s'agit d'un service public industriel et commercial, ce qui implique que toutes les villes de plus de 3000 habitants doivent reporter les recettes et les coûts du service dans un compte annexe de la municipalité. Le principe selon lequel "l'eau paie l'eau" impose que les recettes du service proviennent uniquement des factures des utilisateurs et couvrent les coûts du service. Comme le service public de l'eau dispose d'un budget annexe, la municipalité peut financer une partie des investissements publics sur le réseau à l'aide de la dette spécifique du service d'eau. Contrairement aux monopoles standards de la théorie économique, les services d'eau ne peuvent en principe pas recevoir de financement par l'impôt. Toutefois, cela ne signifie pas que leurs objectifs ne sont pas liés à des objectifs politiques. Le fait que la propriété des réseaux soit publique et que la fiscalité ne puisse financer la production rend l'étude du secteur particulièrement intéressante. Ces règles incitent effectivement à se concentrer uniquement sur les différences de mode de gestion.

Tous les chapitres de la thèse s'appuient sur deux bases de données. Pour les besoins spécifiques de chaque étude, ces bases de données ont été combinées avec d'autres bases. Le premier jeu de données est la base IFEN-SOeS collectée par l'Institut Français de l'Environnement et le Ministère de l'Environnement. Il s'agit d'une enquête nationale sur les services publics de l'eau. Cet échantillon est représentatif de la population française et des collectivités territoriales: les différentes tailles de collectivités territoriales sont proportionnellement représentées et les communes de plus de 5000 habitants sont toutes incluses. Il y a eu quatre collectes de données au cours des dix dernières années. La collecte de données est réalisée en deux étapes. Les municipalités remplissent la base de données qui est ensuite vérifiée par le Ministère de l'Environnement. La base IFEN-SOeS est la seule base nationale représentative des services publics d'eau en France. La base de données contient des informations sur la consommation d'eau par les clients domestiques, la structure de la facture d'eau et les caractéristiques des services d'eau à l'échelon municipal. Cette base de données a été fusionnée avec une base de données de l'INSEE qui concerne les revenus des ménages et avec une base de données du Ministère de la Santé qui contient des informations sur la qualité de l'eau.

La deuxième base de données a été construite spécifiquement pour la réalisation de cette thèse de doctorat. Elle est basée sur la collecte d'une base de données unique regroupant 177 grands services d'eau pour 2009. La collecte a été menée en partenariat avec la Lyonnaise des Eaux. La collecte des données s'est déroulée de la manière suivante. Nous avons lancé une collecte de données sur les 720 plus grandes villes de France, ce qui représente 320 services d'eau. Nous avons obtenu des données pour 297 services publics et un échantillon complet de 177 services d'eau représentant environ 1000 municipalités présentes dans la base IFEN-SOeS. Nous avons donc un ensemble de données couvrant des indicateurs financiers tels que les recettes et les coûts du service.

Les questions de recherche examinées dans la présente thèse sont étroitement liées à la gestion du service public de l'eau en France. Les résultats et les principales conclusions peuvent néanmoins être étendus à l'ensemble des industries régulées et même aux questions d'organisation de l'entreprise. La question du faire ou "faire faire" et la question de l'intégration verticale ont par exemple été étudiées empiriquement dans une longue série d'articles scientifiques remontant au moins à Monteverde et Teece [1982] et Joskow [1985], et couvrant tous les secteurs, du ciment (Hortacsu et Syverson [2007]) à l'industrie cinématographique (Gil [2007]) et bien d'autres (voir Shelanski et Klein [1995], Richman et Macher [2008] et Bresnahan et Levin [2012] pour des revues de littérature approfondies). L'efficacité et l'équité des tarifs mis en œuvre sont également un sujet largement étudié dans la littérature sur les industries réglementées (Ito [2010]), la fiscalité (Saez [2004]) et le comportement des consommateurs (Lambrecht et al. [2007]). Nous discutons en détail les implications, les contributions et les extensions possibles dans chaque chapitre et dans la conclusion générale de la thèse.

## Première Partie: Choix Organisationnels et Performance

Dans la première partie de cette thèse, nous nous intéressons aux liens qui existent entre théorie des coûts de transaction et théorie de la ressource et choix organisationnels d'une part, et à l'impact de ces choix organisationnels sur la performance des organisations d'autre part. Généralement, la stratégie empirique dans la littérature a été de relier les choix organisationnels observés à des mesures de frictions contractuelles et, dans certains cas, de lier choix organisationnels et performance. Dans ce chapitre, nous considérons deux niveaux d'analyse des choix organisationnels: l'organisation du service public de l'eau, c'est-à-dire déléguer ou gérer directement, et la question de l'approvisionnement en eau, autrement dit l'utilisation des ressources propres en eau ou le recours à l'importation de ressources.

Cette première partie est divisée en deux chapitres, tous les deux ancrés dans un cadre théorique basé sur la théorie des coûts de transaction, notamment sur les articles phares de Coase [1937] et Williamson [1975], et la théorie de la ressource (Penrose [1959] et Wernerfelt [1984]). Pour les théoriciens des coûts de transaction, l'origine de l'inefficience d'une organisation vient du décalage qui peut exister entre la forme organisationnelle choisie et la nature de la transaction. La théorie des coûts de transaction met en avant le fait que la gouvernance des échanges économiques est coûteuse et que les formes organisationnelles diffèrent dans leur capacité à faciliter les échanges, ce qui dépend de l'environnement dans lequel les transactions ont lieu. Les choix organisationnels doivent donc avoir pour objectif la réduction des coûts de transaction, qui sont à la fois les coûts d'administration et de contrôle, et plus spécifiquement les coûts de négociation, d'écriture et d'exécution des contrats (Williamson [1975]). La théorie prédit que lorsque la spécificité des actifs est importante, autrement dit lorsque les investissements ne sont pas redéployables sans coûts, la hiérarchie, forme organisationnelle basée sur l'autorité, devrait être préférée au marché, forme organisationnelle basée sur le mécanisme de prix, car elle permet de diminuer le risque d'opportunisme du délégataire.

Toutefois, la théorie des coûts de transaction ne prend pas en compte le fait que les organisations développent un certain savoir-faire et des capacités qui prennent la forme de routines au sein des organisations où qui sont incarnées par le savoir-faire des employés ou des managers de l'organisation. La théorie de la ressource s'appuie sur deux hypothèses. D'abord, elle reconnaît l'existence d'un marché des facteurs de production sur lequel les organisations peuvent échanger les ressources nécessaires leur permettant de créer un avantage comparatif. Ensuite, la théorie de la ressource insiste sur le fait que les ressources qui permettent un avantage comparatif persistant sont plus larges de leur nature et plus difficile à accumuler que les actifs physiques et les facteurs de production mis en avant dans la théorie économique néoclassique. La théorie de la ressource suppose simplement que les organisations internalisent les activités pour lesquelles elles ont un avantage relatif et, à l'inverse, externalisent les activités pour lesquelles elles n'ont pas d'avantage relatif. Les organisations ayant la capacité d'exploiter des ressources précieuses qui leur sont spécifiques auront donc tendance à choisir une organisation hiérarchique pour la gestion de leurs échanges. Un simple cadre d'analyse combinant théorie des coûts de transaction et théorie de la ressource permet de comprendre les choix organisationnels des collectivités territoriales. Nos résultats montrent que les services les plus complexes sont plus souvent délégués au secteur privé, de même que les municipalités ayant une expérience contractuelle ont plus tendance à avoir recours à la gestion déléguée.

Le premier chapitre intitulé "Do Markets Reduce Prices?" porte sur le lien entre choix organisationnels et performance. A partir d'un échantillon de 2455 communes observées sur quatre années, nous évaluons l'impact relatif de la gestion privée sur des indicateurs complémentaires de la performance du service. La gestion privée entraîne des prix plus élevés malgré la prise en compte de la complexité du service. Même en considérant des services qui ont des caractéristiques similaires, nous retrouvons toujours un écart de prix positif en faveur de la gestion directe. Afin de renforcer la validité interne de nos résultats, nous nous intéressons ensuite aux services d'eau qui ont changé de mode de gestion. Les services qui sont passés de la gestion publique à la gestion déléguée connaissent en moyenne des hausses de prix mais ces hausses de prix n'interviennent que plusieurs années après le changement. En revanche, les services qui passent de la gestion déléguée à la gestion publique connaissent des baisses de prix dans les années qui suivent le changement mais l'effet à plus long terme n'est pas significatif.

Outre le prix, nous utilisons plusieurs indicateurs de performance comme la qualité de l'eau et le niveau de la dette du service d'eau. En moyenne, la gestion déléguée se caractérise par des prix plus élevés mais également par une meilleure qualité de l'eau et un moindre niveau de dette du service d'eau. Cela peut être interprété comme étant le résultat des différentes “préférences pour la dépense” des dirigeants du public et du privé (Williamson [1963]). Les choix organisationnels peuvent être également le résultat des différentes préférences des manageurs publics et privés pour l’accès au service, la qualité de l’eau ou les distorsions potentielles sur le marché de la dette et donc *in fine* le report des coûts du service sur le contribuable.

Les résultats sont intéressants pour plusieurs raisons. En premier lieu, les défenseurs de la gestion directe seraient surpris de la faiblesse de l’écart de prix qui existe entre gestion publique et gestion déléguée lorsque l’on prend en compte la complexité du service et les ressources des municipalités. De la même manière, notre résultat est surprenant pour ceux qui pensent que le recours au marché permet de baisser les prix. Par ailleurs, nos résultats montrent qu’il est nécessaire de regarder des indicateurs complémentaires de performance pour mieux évaluer et mieux comprendre les écarts de performance.

Le second chapitre intitulé “Make or Buy in Water Markets” s’intéresse aux raisons pour lesquelles les services d’eau utilisent deux sources d’approvisionnement - la production directe et l’import d’eau - pour répondre à la demande de leurs abonnés, une pratique que nous appelons l’approvisionnement concurrentiel ou parallèle. La théorie des coûts de transaction utilise généralement une dichotomie pour expliquer les frontières de la firme. Les entreprises peuvent internaliser ou externaliser la production d’un bien, c’est-à-dire faire ou “faire faire”. Toutes les études empiriques citées plus haut ont adopté cette dichotomie. Or, les entreprises utilisent souvent les deux modes d’approvisionnement en produisant directement une partie du volume de biens et en externalisant la production d’une seconde partie du volume du même bien. Si la plupart des organisations peut être singulièrement considéré comme ayant recours à l’un ou l’autre des deux modes d’approvisionnement, une grande partie d’entre elles combine les deux modes d’approvisionnement. C’est le cas dans le secteur de l’eau en France où une majorité des services d’eau a recours à l’import alors même qu'ils produisent directement de l'eau pour leurs abonnés.

L'utilisation de modes d'approvisionnement parallèles a été étudiée par plusieurs auteurs de la littérature en stratégie. Une des premières études est celle d'Adelman [1949] qui estime que les firmes ont recours à ce mode d'approvisionnement en période d'incertitude, reportant ainsi les fluctuations de la demande sur les fournisseurs. Porter [1980] défend l'idée que le recours à l'externalisation d'une faible partie de la production permet d'augmenter la connaissance du processus de production. La question du "make and buy" a été récemment évoquée dans plusieurs papiers empiriques (Parmigiani [2007], Parmigiani and Mitchell [2009]) et théoriques (Puranam et al. [2012] and Krzeminska et al. [2012]). Le chapitre contribue à cette litérrature récente en étudiant non seulement la décision d'avoir recours à l'approvisionnement concurrentiel (Parmigiani [2007], Parmigiani and Mitchell [2009]) mais également l'impact d'une telle décision sur la performance des organisations. Le chapitre discute également des différentes théories de l'approvisionnement parallèle, en insistant notamment sur la différence qui peut exister entre cette forme organisationnelle et les modes de gouvernance hybrides identifiés par Williamson [1991]. Notre argument est que l'approvisionnement concurrentiel ne peut être considéré comme une forme hybride de gouvernance puisqu'il ne s'agit pas d'une forme de gouvernance unique mélangeant la hiérarchie et le marché mais bien de l'utilisation de deux formes de gouvernance différentes pour la production d'un même bien.

Notre cadre théorique s'appuie sur la théorie des coûts de transaction et la théorie des ressources. Si les hypothèses de la théorie des coûts de transaction semblent largement invalidées, les hypothèses de la théorie des ressources trouvent un écho dans nos résultats. En effet, la spécificité des actifs n'a pas d'impact significatif sur la décision d'adopter l'approvisionnement concurrentiel. De même, la complexité du service est positivement corrélée à une augmentation de l'approvisionnement concurrentiel, ce qui invalide l'hypothèse que la complexité entraîne une plus grande incomplétude contractuelle. En revanche, les résultats montrent que les municipalités qui ont une expérience contractuelle ont plus souvent tendance à avoir recours à l'approvisionnement parallèle. De même, les municipalités qui ont les capacités de production les plus faibles auront tendance à avoir recours à l'approvisionnement parallèle. La question est alors celle de l'impact sur la performance d'un tel choix, que ce soit sur le prix ou une autre mesure de la qualité du service comme la qualité de l'eau ou le rendement du réseau. A priori, un service qui décide d'importer de l'eau le fait parce que les services avoisinants ont des coûts de production plus faibles. On peut alors s'attendre à ce que les services qui importent aient des prix moins élevés. Toutefois, il est possible que l'on observe exactement l'inverse parce que la contractualisation pour le transfert des ressources entraînes des coûts de transaction ou tout simplement parce que le recours à un autre mode d'approvisionnement pour faire face à l'incertitude est assimilable à une prime d'assurance.

Nous nous intéressons ensuite à l'impact de la sélection de ce mode de gestion sur la performance du service d'eau. Nos résultats montrent que le recours à l'approvisionnement parallèle entraîne une augmentation du prix de l'eau. Cela semble confirmer l'existence de coûts de transaction et d'une prime d'assurance. L'approvisionnement parallèle permet de faire face à une incertitude sur l'évolution de la demande, notamment à certaines périodes de l'année.

La partie I étudie les motifs des choix organisationnels et leur impact sur la performance. Dans la deuxième partie, nous nous intéressons à l'efficience de l'industrie et aux liens qui existent entre l'efficience globale et les choix organisationnels réalisés au niveau de la municipalité.

## Deuxième Partie: Efficience et Equité dans les Services Publics

La deuxième partie de la thèse considère les choix organisationnels comme étant exogènes. Il ne s'agit plus de mesurer la performance des services mais la performance de l'industrie mesurée par l'efficience technique et allocative. Nous évaluons d'abord l'efficience technique d'un jeu de services représentatifs de l'ensemble des services d'eau. Un tel exercice nous permet de comparer l'efficience relative des choix organisationnels. Nous évaluons ensuite l'efficience économique de l'industrie, mesurée comme sa capacité à mettre en place des tarifs amenant à une situation Pareto-optimale. Nous proposons également des réformes tarifaires permettant d'améliorer la performance des services publics. La deuxième partie est divisée en deux chapitres.

Dans le chapitre 3, intitulé "Efficiency in the Public and Private French Water Utilities: Prospects for Benchmarking" nous calculons une frontière d'efficience pour 177 services comptant plus de 15000 habitants. Afin d'identifier les inefficiences managériales et les différences structurelles qui existent entre les services, nous évaluons la capacité des unités de décision à minimiser leurs recettes au regard de la production d'eau, de la gestion du réseau et des clients et de la performance du réseau, en comparaison de la performance des autres services de notre base de données. Nous pensons que les services les plus efficients sont ceux qui arrivent à gérer le service d'eau en minimisant leurs revenus, c'est-à-dire en couvrant leurs coûts et en limitant leurs marges opérationnelles. En effet, des prix trop élevés reflètent à la fois des coûts élevés et la recherche de marges importantes, ce qui peut entraîner des distorsions sur le marché. Toutefois, l'efficience technique n'est pas seulement liée à l'efficience managériale mais également aux caractéristiques structurelles des services et à un facteur "chance" ou "malchance" (c'est-à-dire le bruit statistique ou un aléa non anticipé) des opérateurs. Nous prenons donc en compte un certain nombre de variables pouvant affecter l'efficience managériale des opérateurs afin de pouvoir correctement évaluer leur performance relative. Pour cela, nous utilisons un modèle non paramétrique (Data Envelopment Analysis, DEA) et un modèle stochastique (Stochastic Frontier Analysis, SFA), dans une approche en trois étapes, telle que développée par Fried et al. [2002]. Les résultats obtenus nous permettent de dissocier l'inefficience managériale, l'inefficience liée au contexte opérationnel et les bruits statistiques. Autrement dit, la performances des services d'eau est corrigée de l'impact du contexte opérationnel et des bruits statistiques.

Cet article contribue à la littérature de plusieurs façons. Premièrement, en plus des indicateurs traditionnels de l'efficience technique, nous prenons en compte la qualité du réseau et des variables environnementales pour mesurer les performances relatives des unités de décision. De plus, nos résultats contribuent à la littérature sur la comparaison entre gestion publique et privée. Ils indiquent que les services en gestion déléguée sont structurellement plus difficiles à gérer. La prise en compte des variables environnementales permet d'augmenter le score d'efficience des opérateurs privés de 0,1 en moyenne contre 0,059 pour la gestion directe. En revanche, même après la prise en compte des variables contextuelles, la gestion privée reste en moyenne relativement moins efficiente que la gestion publique. Les régies ont ainsi un score d'efficience moyen de 0,883 contre 0,823 pour les services en gestion déléguée. Au final, si l'écart de performance entre gestion publique et privée est réduit après la prise en compte des variables structurelles, il reste significatif et réside en partie dans une plus grande dispersion de l'efficience des services en gestion privée.

Dans le chapitre 4, intitulé “Efficiency and Equity in Two-Part Tariffs: The Case of Residential Water Rates”, nous étudions l'efficience allocative du marché de l'eau en France. Nous nous intéressons au rôle essentiel de la tarification et de la régulation pour améliorer l'efficience et l'équité dans l'usage de l'eau. Comme dans beaucoup d'industries réglementées, dans le cas le plus simple, le prix de l'eau est divisé entre une partie fixe et une partie variable qui dépend de la consommation d'eau. Un des résultats standards de la régulation des services publics révélé par Coase [1946] est que l'efficience économique ne peut être atteinte que par un alignement des prix marginaux sur les coûts marginaux avec une partie fixe égale au coût fixe moyen. Bien qu'il soit obligatoire d'avoir une tarification en deux parties en France, il est intéressant d'étudier l'écart qui existe entre la réalité et la théorie et les coûts d'efficience qui résultent de cet écart.

Le présent chapitre applique le cadre standard de l'analyse du monopole pour répondre aux questions suivantes: (1) Les prix marginaux sont-ils différents des coûts marginaux ? (2) Quels sont les effets distributifs de la mise en place de tarifs coasiens ? (3) Les tarifs réformés prennent-ils mieux en compte les considérations d'équité ? (4) Quels sont les coûts d'efficience des déviations observées de la tarification au coût marginal ? Le chapitre examine une base de 4500 municipalités représentatives au niveau national pour l'année 2008.

Nous constatons que les prix marginaux sont supérieurs de 8% aux coûts marginaux. Un tel écart entraîne une perte sèche car certains ménages consomment moins d'eau qu'ils ne le feraient avec des tarifs plus proches des coûts marginaux. Une réforme des tarifs permettrait d'augmenter considérablement le bien-être des consommateurs mais aurait peu d'effets redistributifs. Par exemple, les ménages habitant dans des villes dont les revenus par unité de consommation sont dans les quatre premiers quintiles subiraient une diminution de leur facture moyenne relativement uniforme, entre 21,45 et 20.07 euros par an. Nous considérons donc un certain nombre de programmes d'aide financière ciblé sur les ménages habitant dans des villes ayant un faible revenu par unité de consommation. Nous comparons ensuite les coûts de ces politiques d'aide aux coûts d'efficience actuels. A partir des élasticités-prix observées dans notre base de données, nous pouvons calculer les gains d'efficience du passage aux tarifs coasiens. Ces gains s'élèvent à 8 millions d'euros en 2008, un niveau qui est faible par rapport aux profits globaux de l'industrie de l'eau en France. Cependant, ces gains d'efficience sont suffisants pour financer des programmes d'aide aux ménages tels que la diminution des frais fixes pour les ménages les plus démunis. Ce chapitre évoque enfin plusieurs raisons qui permettent d'expliquer les distorsions actuellement observées, telles que la stratégie de maximisation du profit des entreprises (cherche-t-on à maximiser le profit à partir des petits ou des gros consommateurs?), la rareté des ressources (les marges correspondent-elles à des taxes pigouviennes?) et le mode de gestion (public ou privé?). Nous discutons ensuite brièvement de la validité des résultats, précisément en ce qui concerne la réaction des consommateurs au prix marginal et l'existence de distorsions sur les marchés connexes, tel que l'assainissement.

## Principales implications politiques et contributions pour les managers

Les résultats de la thèse vont dans le sens de plusieurs implications pour la régulation du secteur et pour les décideurs public et privé. Les résultats de la première partie vont dans le sens de la nécessaire prise en compte par les décideurs publics de leur capacité à contractualiser et de la nature de la transaction afin d'éviter le mésalignement dans le choix de la forme organisationnelle. La performance organisationnelle dépend de la capacité des décideurs publics et privés à prendre en compte ces caractéristiques. La prise en compte des caractéristiques de la transaction et des ressources des organisations permet de purger l'écart de performance entre modes de gestion.

La présente thèse révèle également plusieurs implications réglementaires. Dans des contrats de long-terme, l'utilisation de la concurrence par comparaison et des méthodes de *benchmarking* peut être un moyen d'accroître la pression concurrentielle sur les entreprises et inciter les services publics "à la traîne" à accroître leur efficience. Une telle évaluation des services publics de l'eau permettrait également d'accroître l'information des décideurs publics et donc de diminuer l'opportunisme qui peut exister dans ce type de contrats.

Enfin, un débat national sur les tarifs de l'eau a été récemment lancé par le gouvernement. Les projets actuels sont basés sur des tarifs en escalier dont le prix augmenterait avec la quantité consommée. De tels tarifs ont toutefois des coûts d'efficience si les prix marginaux diffèrent en moyenne des coûts marginaux alors que les familles nombreuses pourraient être négativement touchées par ce genre de tarifs. A l'inverse, la recherche de l'équité - par des transferts vers les consommateurs les plus démunis - peut avoir un impact négatif sur l'efficience du marché. Ce compromis entre efficience et équité a été largement étudié en économie (Baumol et Bradford [1970]) et est également un sujet brûlant de la recherche en gestion (Klein et al. [2010]). En raison des implications du sujet, des analyses plus détaillées utilisant des données réelles doivent être menées afin de mieux comprendre les comportements des consommateurs et l'impact de réformes tarifaires sur leur bien-être. Une telle connaissance du comportement des consommateurs permettrait aux décideurs public et privé d'avoir de véritables capacités stratégiques par rapport à leurs concurrents et à l'autre partie.

Enfin, les méthodes utilisées dans cette thèse de doctorat peuvent être largement exportées vers d'autres secteurs régulés et plus généralement dans l'étude des choix organisationnels.

**Mots-clés:** Services Publics, Partenariat Public-Privé, Eau, Efficience, Equité, Organisation Industrielle, Coûts de transaction, Capacités, Théorie de la Ressource, Management Public.