Thirsting for Efficiency: Technological and Transaction-Cost Explanations for the Municipalisation of Water Supplies

Álvaro Ferreira da Silva

Abstract

This chapter advances two main explanations for the waterworks' municipalisation trend after the late nineteenth century. On the one hand, the importance of abundant water in sustaining the technological innovation behind the new sewerage system. On the other hand, the difficulties in designing a proper regulatory framework for private firms in the water industry motivated by the high transaction costs in designing and enforcing contracts. Paradoxically, this argument is based on the study of a European city where private ownership and operation subsisted until the late twentieth century. Asking why Lisbon failed the municipalisation trend flips the conventional question on the reasons for increasing public ownership in water supplies. In a similar way to the deployment of counterfactual arguments for dealing with research questions, asking why municipalisation did not occur is similarly relevant, and perhaps even more illuminating in explaining the municipalisation movement.

1 Introduction

Large transport, sanitation and energy infrastructure projects changed the way of life during the nineteenth century. Railways by the mid-nineteenth century, gas and then later electricity in the late nineteenth and early twentieth centuries, water supply in the second half of the nineteenth century, all began creating the networked city and the spaces within it that characterise modern life (Tarr and Dupuy 1988). These different infrastructure projects started out and flourished as private

Á. F. da Silva (✉)
Nova SBE (Nova School of Business and Economics), Carcavelos, Portugal
e-mail: alvaro.silva@novasbe.pt

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initiatives, challenging, from their inception, the very roots that the classical liberal economy had been building up. At the same time that Ricardo, Say and Stuart Mill were extolling the benefits of competition and the smooth adjustment of atomistic production and consumption, these infrastructures were creating monopolistic operations that not only had potential impacts on consumer welfare, but also large and wide-reaching externalities. These new infrastructure projects were calling into question the assumption that economic policy should be based on distant and benevolent state oversight of private initiative, with management models that would not be radically different from those of past business enterprises.

Railways shaped managerial and corporate finance models (Chandler 1979). Their capital intensity required the creation of more and larger joint-stock companies than any other previous business venture, hence the need to resort to capital markets to finance their construction. Long railway lines and the consolidation of different lines into unified networks created the first complex managerial organisations, foretelling the large multidivisional manufacturing firms to come. Capital intensity remained a shared characteristic with other infrastructure projects.

These large transport, sanitation and energy infrastructure projects relied on stand-alone operations in a specific city or country. However, from the outset, many depended on foreign sources of capital to develop these new ventures in distant locations—peripheral European countries, colonial regions or newly independent countries overseas. New patterns of direct foreign investment and multinationals emerged: free-standing companies (Wilkins 1988), consortia of investors, investment trusts, and dual-board firms (Silva 2014) created a panoply of organisational conduits to channel technology, capital, and management to these stand-alone firms in faraway locations (Lopes et al. 2018).

These infrastructures also shared another characteristic: they required long implementation phases at a time when capital investment in specific assets was at its height. It was during this implementation phase that investment in technology and knowledge became embodied in railway, energy, and sanitation solutions (Casson 1998).

Although this chapter focuses on the establishment of water supply networks, they inevitably shared many characteristics with other infrastructure projects of that period. They did not incur the managerial complexity of railways, but their peculiar economics and managerial challenges were nevertheless similar. Emphasising this lineage puts the water industry into perspective.

A sanitary transformation was in progress across European and North American cities during the second half of the nineteenth century (see Silva 2006 for an overview). Health problems had plagued these cities for many centuries, but they became aggravated when urban growth escalated following the onset of industrialisation. The solution of the problems of epidemic outbreaks in the urban context and the improvement of general living conditions resulted from technological innovations in sanitary equipment (Stine and Tarr 1998). In the nineteenth century, technological innovations in sanitation depended on the introduction of modern water supply and sewerage networks. This chapter argues that technological integration between water provision and sewerage is essential to understanding the

municipalisation movement of the late nineteenth century, when public utilities' ownership and management was widely transferred to local public entities (for an overview of the municipalisation trend, see Robson 1935, Falkus 1977, Jacobson and Tarr 1996, and Kellett 1978; for the specific case of water supply, see Millward 2005: 41 ff, Troesken and Geddes 2003, Hassan 1985).

This chapter goes on to argue that improved health conditions also stemmed from organisational innovation in the way that sanitation technology was, in the meanwhile, mastered and synthesised into a solution planned for each specific city in conjunction with its operation management. Thus, the second argument of this chapter addresses the importance of incentives to firms that will ensure they might recover their investments in capital-intensive networks.

The literature on the modernisation of methods of water supply discusses the reasons that public companies took over waterworks from the late nineteenth century onward (see the section "Private or public ownership of water utilities" below). The current scholarship on the municipalisation trend proposes different reasons, but this chapter advances two main explanations: the importance that abundant water had to sustaining the technological innovations behind the new sewerage networks; and a transaction-costs explanation deriving from the difficulties in designing a proper regulatory framework for private enterprises.

The chapter addresses these issues and maintains this conversation with the literature on the municipalisation of water supply from an unusual perspective. Rather than actual municipalisation, it instead discusses the reasons that the water supply remained under private management in Lisbon for more than one century. Studying these reasons holds interest for understanding the specific case of the Portuguese capital city at a time when municipalisation was already widespread. However, the case is first and foremost relevant as a counter-argument for elucidating just why municipalisation occurred in other contexts. In this regard, the conversation with the literature on municipalisation (Sect. 5 below) takes on a particular approach. Instead of looking at cases in which municipalisation occurred, this chapter flips the argument and considers an instance when municipalisation did not happen.

The relevance of explaining the late nineteenth century trend towards municipalisation lies in dealing with a historical conundrum on the private-public relationship over time. This also illuminates current debates around the private and public ownership of water.

2 The Creation of the Water Supply and Sewerage Networks

The sanitary transformation contained two interrelated components. On the one hand, the modern water supply, characterised by water piped into households, relying on centralised and automated water distribution (Tarr 1985). On the other hand, modern sewerage, relying on the introduction of the water carriage system for

waste disposal and also based on automated, centralised and capital-intensive systems that deployed water for sewage drainage and disposal (Melosi 1994; Tarr 1984 and 1988). The implementation of these two separate but interrelated services spanned different chronologies (Tarr and Konvitz 1987), with the first cities involved having already implemented a piped water supply to households by the early nineteenth century.

Contrastingly, the water-carriage system for sewage disposal, as a basis for these new sewerage services, emerged only during the second half of the nineteenth century, particularly in the closing decades. This divergent chronology generated consequences for the welfare and mortality of urban inhabitants. Indeed, expanding the water supply without proper sewerage services was responsible for increasing the mortality rate, as water sources steadily became more polluted (Tarr 1996: 8–9).

The interrelationship between water supply and sewerage services stems from the importance of water as an input for sewage drainage. In order to remove solid waste from the toilet flush and sewer pipes, the major technological innovation behind the modern sewerage system incorporated the usage of water as a draining and cleansing agent. This explains why both systems were interrelated in the sanitation system, which may be exemplified in the diagram set out in Fig. 1.

This integrated water and sewerage system depends on the effective functioning of either the water-supply network or the sewerage network. A universal and abundant water supply is critical for the sewerage network, based on the water

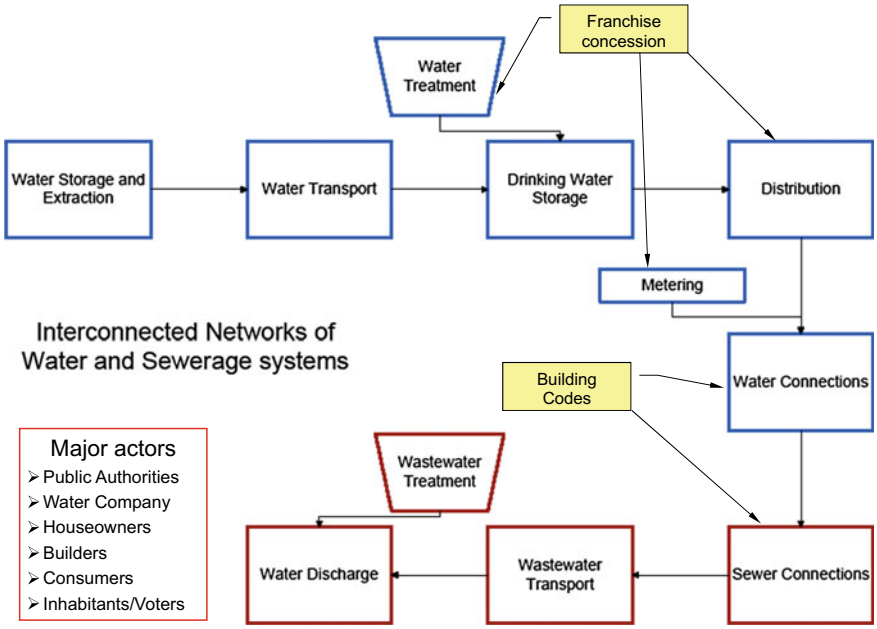

Fig. 1 Interconnected networks of water and sewerage systems

carriage technology. An efficient sewerage network should, furthermore, prevent toxic leakages of sewage from affecting the quality of the piped water. Its careful construction should preclude wastewater overflows whenever storm water drainage is combined with sewage and domestic water within the same sewerage network.

The two different but interrelated networks then interwove a web of contractual and regulatory instances. Each had different managerial and ownership solutions for constructing and running them. At the beginning of the modern water supply, the waterworks were usually private. Contrastingly, sewerage networks were constructed and run by public authorities at the local level. Two different managerial authorities supervised each of the networks, running different contracts with consumers and homeowners/tenants, developers/builders and business consumers. As the financing of sewerage networks was based on taxes, rather than on pricing its usage, inhabitants/citizens became another pole in the transactions associated with this interconnected system. Moreover, the regulatory web of norms and contractual guidelines connected the municipal authorities not only to private water companies, developers and builders, but also to homeowners and tenants.

Separating these interrelated networks between two managerial authorities was deemed an inappropriate solution by Edwin Chadwick, the British mid-nineteenth century reformer. He not only believed that water supply and sewerage represented closely interconnected problems, but also that they required similar technological and organisational solutions, and thus proposed that the same company might provide both ranges of services. Nowadays, it is indeed common for the same company to manage water supply and sewage disposal: Veolia Environment (the incarnation of the old Compagnie Générale des Eaux), Lyonnaise des Eaux, Biwater PLC, Thames Water, Severn Trent, AcquaAmerica, only a handful of names from an extensive list referring to other cases in which management consolidation took place.

In the late nineteenth century, new waterworks were ever more frequently managed by local councils, with the old, private waterworks having been taken over by municipal authorities. This consolidation of water and sewage network management under the same entity—in this case, public, municipal authorities—kept with the trend foreseen by Chadwick half a century earlier. The literature has offered several reasons for this municipalisation process. Before weighing these reasons, we first need to look at the specific economics of water supply, which may illuminate the organisational solutions conceived for its provision.

3 The Economics of Network Utilities and Water Supply

The modern water supply requires a fixed network in order to deliver its services. This networked dimension differentiates between modern waterworks, relying on centralised and automated water distribution, and localised and labour-intensive water supply, typical of the traditional provision by water peddlers who sold water door to door. Considering that this networked characteristic of water supply

resembles other utilities, this characteristic similarly implies that coordination of every section of the system is essential to its efficiency. Partial investments in any point of the network only make sense whenever the performance and organisation of the entire system are efficient.

The second characteristic of the modern water supply infrastructure reflects the large amount of capital invested in waterworks (aqueducts, dams, pipes and reservoirs) (Cutler and Miller 2006). It is exemplary of an industry in which the sunk costs are very high, meaning that they cannot be swiftly recovered. The high capital costs prevent any rapid amortisation of the initial investment and exert considerable pressure on the subsequent profitability of the venture. Additionally, the limited cash flows in the first stages of operation generated from water sales are unable to amortise the capital costs, except after the passage of many years.

Investments in waterworks assets are also specific to water supply systems, and hardly transferable to any other economic activity. Waterworks incorporating aqueducts or pipes laid down under streets are almost entirely irrelevant to any purpose other than water supply. The specificity of this investment, the high sums of capital involved, and the concentration of the economic activity in supplying one single good prevent a smooth exit from the industry.

These investments also deploy long life-cycles, typically between 20 and 40 years, which makes it possible to postpone maintenance and replacement investments—and, consequently, to "underfund" such activities—for quite long periods of time.

Finally, and still furthermore, from the perspective of production, the modern water supply is a classic case of a natural monopoly in which a single firm may satisfy the entire local demand at lower total cost than any other combination of firms (Sharkey 1982). The network itself also represents an obvious case in which duplication raises the total costs of supplying a market.

These characteristics of the water supply as a network utility, with high sunk costs, non-redeployable assets and natural monopoly issues, are similar to those of other network industries during the nineteenth and early twentieth centuries. Some are even more greatly exacerbated in other utilities, as is the case with capital intensity and sunk costs. For instance, the electric power industry displayed a much higher intensity of initial capital costs, correspondingly making it harder to pay back capital remuneration over the initial years of operation from cash flows arising from sales (Silva and Bartolomé, forthcoming).

The water industry of this period also displayed certain other specific features when considered from the perspective of consumption. The first comes from its very character as a natural monopoly. A single firm supplying such a good or service might be tempted to abuse its market position through an inclination to levy higher prices.

Another feature within the consumption perspective derives from the positive externalities associated with water consumption. In dealing with nineteenth-century sanitary problems, continuous and abundant water consumption was essential to resolving urban health problems. The introduction of the water carriage system for waste disposal also created an automated, centralised and capital-intensive system

through the building of sewers, whose performance depended upon the efficiency of their water supply (Hamlin 1992; Melosi 1994; Tarr 1979 and 1984). The deployment of water as a draining agent in the sewerage system implies that the price could not exclude the population from accessing water, considering its impact on resolving the leading nineteenth century city sanitary problems. In this sense, even if the scope existed for excluding someone from the consumption of piped water—a situation that differs from that which occurs with public goods, such as public lighting and defence, for instance—positive externalities act to potentially provide for the universal consumption of water.

As a rule, markets and private enterprises are much better adapted to supplying goods and services that are strictly private (which allows for the exclusion of any individual consumer). However, considering the positive externalities associated with the universal consumption of water, the public provision of water might therefore be perceived as a possible institutional solution.

4 Transaction Costs and Contracts

The superiority of private management in dealing with water supplies was taken for granted throughout most of the nineteenth century. The provision of water to cities was not considered fundamentally different from other economic activities, provided that several contractual conditions were agreed upon in order to deal with the specificity of the business (Falkus 1977: 140; Millward 1991: 99; Robson 1935: 304). Public administration might provide order, fight against fires, and maintain public spaces, but it should not intervene in other types of initiative. In Portugal, when the piped water supply became a theme of political discussion and decision, private management was also the solution envisioned, even though the arguments were much less insightful in their theoretical defence of the superiority of private undertakings. More critical were the references to the financial burden that any public water provision would create for state financial resources. A private company, able to raise capital by issuing shares to the public, appeared to offer the best prospect for improving the water supply, considering the capital intensity of modern waterworks. The emulation of the technological solutions implemented abroad extended to the governance and institutional model. The first governmental proposal for tendering bids to provide piped water to Lisbon states the importance of supplying water "in the same fashion as used in other European cities, where private companies are responsible for the introduction of new and modern habits in personal hygiene" (preamble to the December 22, 1852 law). The public provision of modern waterworks did not appear to be a solution in the mid-nineteenth century, in contrast to what was the case with the public construction and management of Lisbon's eighteenth-century aqueduct.

However, the production specificities associated with water supply, high sunk costs and the specificity of waterworks led private entrepreneurs to secure their property rights against opportunistic behaviours from the administrative body that

granted the franchises. From the point of view of private investors, several dangers might emerge and had to be anticipated. They may be summarised in two instances. The first encapsulated the need to reward such a high and specific investment. The administrative guarantee of a minimum rate of return to the investment might have represented a solution to this problem, as was indeed usual in the railway transport sector. Another solution might have involved an extension in the limited franchise monopoly, securing property rights and giving the time for long-term strategies for recovering capital and profits, in keeping with the life-cycle of water networks. As the business was new and needed an extended period to mature, these concerns about capital return were also inescapable. In addition, the municipality represented one of the main clients for water supply. Thus, the company feared becoming a hostage, whether of the local administration or of decisions made by the central government. As the specific features of the assets prevented any exit from the business, strong incentives existed for trying to draft very detailed contracts that strove to cover any possible situation that might lead the firm into such a hostage position.

From the consumer's point of view, the private management of the water supply incurred two major shortcomings, even if they were susceptible to circumvention through contractual regulation. Firstly, a monopoly firm with a long-term contract raised the possibility of abuse of its market position, increasing prices or lowering the service standard. In a second instance, the introduction of piped water sought to boost the quantity and the quality of the water supplied, considering the positive externalities associated with the improvement of sanitary conditions. Therefore, the private operation of the water supply was to consider this general goal when developing the works intended to introduce larger quantities of water into the city and make the service available to the entire population. The franchise contracts tried to address the first problem through price regulation. In order to face the second problem, the contracts tried to secure the investments necessary to increase the quantity and quality of the water supplied in line with population growth, stipulating, for instance, a minimum quantity of water provision, whether in bulk terms or per capita.

The problem facing investors and the administration involved devising an institutional device that might balance different interests and powers. This tension between the investor and the consumer could be sidestepped by state ownership, which, furthermore, held the coercive power to finance the sunk capital without requiring the assurance of future returns from the utility. Alternatively, it might attempt to reconcile private ownership with the political power of consumers through the private franchise monopoly. In either case, the water supply networks would operate under the terms set by the state.

In the mid-nineteenth century, private operation under limited franchise monopoly constituted the most prevalent institutional alternative. This owed much to the then-contemporary experiences of railroad construction and operation, as well as to the theoretical principles associated with the work of Edwin Chadwick. He differentiated traditional market competition, "competition within the field," which assumed a large number of firms competing in the market, with his new concept of

"competition for the field," based on competition between several bidders to gain the exclusive right to supply water to the entire local market (Demsetz 1968; Ekelund and Herbert 1990). This competitive bidding process would, in a certain way, replicate the social efficiency of "competition within the market." However, the efficiency of the competition-for-the-field approach ultimately depended on the contractual terms, the power of vested interests, and information on the industry.

The design of contracts is always imperfect, as is the information held on every possible issue as well. Institutional economics stresses the importance of bounded rationality, or the costs of acquiring and processing information, and opportunism, or the use of astuteness or fraud to distort outcomes to the benefit of one party. The problems associated with contracts for regulating water supply involved these two features. The regulation of the modern water supply has to deal with asset specificity on the part of the utility, bounded rationality on the part of the regulator and the concessionaire (incomplete and costly information about the options open to the utility and the prevailing forecasts) and opportunism by both parties. Regarding opportunist behaviour, private enterprise attempts to deliver those services that are the most profitable, rather than the most socially inclusive. The regulator's opportunism takes advantage of the costly investment in sunk and specific assets to threaten the company, reneging on contractual clauses or trying to renegotiate contracts in such a way that the utility fears becoming a hostage of the regulator. In summary, a network utility such as a modern water supply involves excessively high transaction costs.

This synthesis of the characteristics of water supply points out the reasons for the necessity of public regulation. In the late nineteenth century, public supply eventually became a realistic solution to the problems associated with providing such a good. The next section summarises the reasons for the trend towards municipalisation.

5 Private or Public Ownership of Water Utilities

The perception that the water industry had to choose a different tack in regard to economic activities than the usual market approach led to a strong movement towards public ownership of the water supply. Indeed, in the late nineteenth century, this trend towards municipalisation occurred in a number of different Western countries (for data on the USA, see Masten 2010; for Britain, see Millward 2000).

The timing and impact of regulation, firstly, and public ownership later has already been well documented (see Millward 2005: 36 ff). The explanations are, nevertheless, more contentious. The evolution from private to public ownership sometimes appears in almost whiggish tones as some inescapable trend towards social modernisation (Jacobson 2000). However, other instances stress ideological reasons while invoking the impact that progressive politics had on defending public control and ownership of waterworks (Hohenberg and Lees 1985: 317–8).

Abuses by private concessionaires, taking advantage of their monopolistic positions, constitute another reason sometimes put forward for including the integration of gas works in the same municipalisation trend (Moorhouse 1986; Millward and Ward 1993).

Other explanations for market failure also feature among the stated reasons for the advance of public waterworks after the late nineteenth century. The positive externalities deriving from universal water supply is one such factor, often emphasising the impact of clean drinking water in reducing epidemics (Melosi 2000; Spar and Bebenek 2009; Tarr 1996; Troesken 1999). Access to capital sources may also represent a case for market failure whenever private ventures lacked easy access to funding. In contrast, public authorities are generally better positioned to attract the confidence of investors, especially in the case of substantial investments (Cutler and Miller 2006; Hassan 1985; Melosi 2000). Finally, institutional reasons might prevent adequate private sector incentives for pursuing the long-term investments compatible with the life-cycle of waterworks. Therefore, regulatory failure over private enterprises (Millward 2005) or increasing regulatory pressure (Troesken 1997) might constitute powerful forces that lead to municipalisation just as much as market failure in capital access or externality issues.

The above explanations mobilise significant contributions to understanding how public policy addressed water supply in ways that are different from approaches to other ongoing market activities. However, as argued by Troesken and Geddes (2003), there is no clear evidence as to just why the public takeover of waterworks emerged as a better option than private management for dealing with the positive externalities of supplying quality drinking water. As they detail: "[A]lthough it is possible that subsidising private companies was politically unpopular and therefore unlikely, this suggests a contractual or political failure, not a market failure" (Troesken and Geddes 2003: 377).

The externalities argument proposed in the literature concerns the quality of water provided to city dwellers, emphasising the positive impact of modern water provision in decreasing mortality and improving urban health. However, this does not especially encapsulate how the water-carriage system of waste disposal of modern sewerage networks depended on water supply. The water carriage system was the technological innovation capable of solving the centuries-old problem of the disposal of sewage and domestic waters. The universal provision of water to city dwellers had positive externalities other than those usually associated with drinking water quality. The use of municipal ownership and control in order to obtain abundant and universal water supply for the modern sewerage system represented one major reason for the taking-over of private waterworks.

In addition, the explanations above fail to incorporate the difficulty in designing a regulatory framework for defending public interests and the positive effects of water supply under a private management regime. High sunk costs and non-redeployable assets rendered private companies vulnerable to administrative opportunism, as already mentioned above. Franchise contracts might stipulate clauses preventing administration authorities from engaging in opportunistic behaviours such as seizing control of the waterworks or imposing abusive rates. Such might also be the case for

protecting consumers through imposing rate caps and standards of service. However, not only were the transaction costs quite high, the bargaining and other recurrent conflicts were also so intense that municipalisation may have emerged as the most efficient perceived solution for dealing with the difficulties in regulating private water supply (Troesken and Geddes 2003; Masten 2010).

The next section adopts the case of Lisbon for exploring the difficulties encountered in designing a regulatory framework for solving the peculiar economic characteristics of water supply, while defending public interest and consumers from abuse and ensuring the property rights of private companies.

6 Designing the Regulatory Framework

The growth and development of the Lisbon water supply has been addressed by several studies. Saraiva (2005), Schmidt (2011), and Saraiva et al. (2014) deal with the technological transformations in this supply and their relationships with the politics that prevailed in nineteenth and twentieth century Lisbon. Other research findings propose more economic and managerial perspectives for understanding why these technological changes took on certain specific institutional and regulatory forms (Silva and Matos 2004; Silva 2006 and 2007). The following paragraphs synthesise the main issues covered by these latter studies.

In Lisbon, the modernisation of the sanitation infrastructure follows the usual chronology: first, the transformation in the water supply, with the franchise tender settled in 1856; subsequently, the modernisation of the sewerage network, with the first plan approved in 1880, even though the actual construction works were delayed for years. The time lag between the technological transformation in the water supply and sewage disposal is similar to other cases and turns out to be not as large as those in certain metropolises, such as London or Paris.

The institutional models also bear similarities to other Western European and American cities: concession contracts signed with a private company for water provision and the public construction and management of the sewage network. The first joint-stock company for providing Lisbon with a water supply network was founded in 1857. Unlike other infrastructural projects in Portugal at that time (for instance, the railways or gasworks), the new Companhia das Águas de Lisboa (Lisbon Water Company) was a Portuguese firm, without any foreign capital involvement in meeting its statutory equity requirement of 1500 contos (ancient Portuguese currency equivalent to c. £350,000), thus, one of the largest limited liability companies in Portugal outside of the finance industry. Proposals from British financiers and engineers with considerable experience in similar works in other cities were thereby rejected, in favour of a domestic proposal, with a governance model prohibiting the concentration of capital into any one single shareholder. The undercapitalisation of the company and its lack of engineering experience delayed the project, and even led to the brief municipalisation of the waterworks between 1863 and 1867, before they were returned

to a relaunched Lisbon Water Company, under new management and with greater financial and engineering muscle.

Notwithstanding these delays and all of the financial and technical difficulties, the waterworks remained under private management until 1975, when the concession contract came to an end within the context of the 1974 democratic revolution in Portugal. Throughout various decades, the private company was able to survive the project management strains of its early decades (1858–1880), the regulatory turmoil experienced in the same period, the economic consequences of World War I and the impact of the post-1919 inflationary surge (Amaral and Silva 2014).

The regulatory uncertainty of the initial decades is particularly interesting to this argument. The renegotiation of the tender clauses between the government and the private company lasted for a further two years after the tender decision in 1856, with the regulatory framework continuing to change systematically over the next four decades. The difficulties in designing contracts that secured the rights of both consumers and private investors, as well as providing assurances against opportunistic behaviours, whether undertaken by the administration or the private company, underlie the volatile contractual situation experienced immediately after the 1856 franchise tender (details in Silva and Matos 2004: Table 3).

This permanent series of negotiations was an experimental approach to designing a regulatory framework for water supply in a situation marked by uncertainty and recurrent conflicts between the municipality and the private company. For instance, the very first tender (1852) included almost no contractual conditions for participants in the competitive bidding process, setting only the period for the concession (20 years, remarkably short for waterworks investments) and the volume of water to be provided (also quite small). The next tender (1855) constitutes a turning point in water supply regulation, introducing the conditions usually established elsewhere for such water supply concessions, which had been absent from the previous tenders simply due to government inexperience in this type of agreement (see Silva and Matos 2004 for the influence of foreign entrepreneurs on the terms of the 1855 tender). For the first time, the terms of the bidding process incorporated the main items of any other contract in effect throughout the second half of the nineteenth century: price regulation (a water price cap) and a standard of service (the minimum volume of water per head to be provided by the company). This standard of service was to be maintained irrespective of any increase in the resident population, thus introducing a dynamic factor into regulating the minimum quantity of water per inhabitant. The bidding terms even included a clause precluding opportunistic behaviours by the franchised firm: for the final five years of the contract, the municipality had to act to control attempts by the firm to lower its standard of service and ensure its conformity. Finally, the contract stated that the municipality would receive any water needed for public service, except for the water used for cleaning sewer pipes.

Price regulation, combined with a predetermined service standard, was thus the regulatory method devised, and it correspondingly rejected the scope for having a rate-of-return alternative. Setting a maximum price sought to prevent the company

from exploring its monopolistic position. The standard of service, defined by the minimum quantity of water for supply to the city, attempted to deal with the positive externalities inherent to water supply. A new contract in 1867, four years after the municipality took over managing the company (see Silva 2004 for details), increased the minimum quantity of water per head and per day by more than 60%, even though the clause requiring the maintenance of the service standard irrespective of the population increase disappeared. The implicit assumption was that the new quantity cap provided more than enough water for the population's needs, even in the case of growth. Such an increase in the previous minimum threshold constituted a strong argument deployed by the company to secure the concession in the wake of the 1864–1867 crisis. Abandoning the standard-of-service clause represented a significant change, as this left the administration without a contractual device for controlling the company's performance, despite its long contractual lifespan (99 years).

The new 1867 contract introduced a more important new feature: compulsory piping, stating that any new building erected in the city after 1872 was to have piped water. Compulsory piping was a means of shaping and maintaining a substantial consumer base (also becoming a rule in the first contract for the Oporto concession in 1882). From the company's perspective, this clause might constitute the corollary of price regulation. As the government did not guarantee the rate of return, enlarging the consumer basis by administrative, as opposed to market, means was critical to the company, due to the significant investments needed in the waterworks in order to modernise the water supply.

The new contractual clause imposing compulsory piping for any new building did not go unchallenged. The city council, trade associations, homeowners and builders stood up in resistance. The company applied the most effective weapon it had: it stated that, should the contractual clause fail to be applied, work on the new Alviela waterworks would stop. The ultimatum was successful, and the compulsory piping regulation received approval in 1880.

Finally, the 1867 contract also introduced a new institutional arrangement for providing public control over company operations. The 1855 clauses for the tender bid stipulated that the government and the municipality should have two representatives on the company's board. The substantial municipal assets (the former waterworks belonging to the Aqueduto das Águas Livres) that the Lisbon Water Company controlled for the duration of the concession justified the presence of these delegates. In 1867, an independent body—a control committee—with members appointed by the government and the municipality was set up to scrutinise company activities (construction of the waterworks, maintenance, operation, levels and quality of service). In order to deal with any disputes between the administration and the company, this also established an arbitration committee. Nevertheless, the activities of these two bodies left no documented traces.

These contracts and the other regulatory devices did not prevent future conflicts between the private concessionaire and the administration, mainly with the city council. The 1858 contract was very detailed when compared with the government's terms of reference for the 1852 contest. The 1867 contract became even

more comprehensive. These contracts underwent discussion for years in a situation that was repeated for the contract signed between the municipality of Oporto and the French water supply concessionaire. However, either the municipal council or the company did not anticipate every possible situation that might appear in the prevailing relations, whether between the company and its customers or the company and the public administration. The perfect contract, one regulating the concession to the private company while capable of securing the business expectations of a new industry alongside the prospects for consumers, simply lay beyond their capacities.

The most important reasons for these conflicts between regulator and concessionaire have been explored elsewhere (Silva 2004, 2007). These recurrent disputes revolved around several issues: the abovementioned compulsory piping for any new building; the waterworks enforced by the concession and the works actually accomplished by the company; the quantity of water provided; the expropriation of private water sources by the company; the enforcement of rights of way; the company use of public resources such as streets; and the water consumed by the administration in addition to the free quota defined by the contracts.

At different times and in different ambiences, clashes between the municipality and the company would erupt. One of the most frequent reasons stemmed from calculating the water consumed by the public administration. According to the contract, the administration should receive a certain amount of water for free. Any excess would be charged at a reduced price (as a rule, half the average private consumer tariff). Up until World War I, public consumption represented about 60% of total water consumption in Lisbon. After accumulating several years of municipal debt owing to disagreements about the levels of public consumption required to be paid beyond the volume of water supplied for free, conflicts erupted. The accumulation of municipal debt compromised the company's operations and deeply stressed the relations between the private enterprise and the city council.

The public administration, on the one hand, had regulatory power over the company and, on the other hand, by far accounted for the largest share of total consumption. The peculiar relationship between the water company and the local administration explains the recurrence of the disputes between the company and the municipality, their bitterness, and even, at times, their virulence. The municipal administration being the company's largest customer and, simultaneously, its principal debtor effectively poisoned the relations between them. This peculiar relationship between client/regulator and utility constituted an additional motivation that consistently drove the former's desire to take over the private company. In addition to any public health reasons, which might arise from better, cheaper and extended water provision, the efforts that the municipality undertook to control the water supply at several points in time can only be explained by the intention to centralise, within the same body, the administration of a service that had the city council as its main consumer.

7 Why Was the Water Supply Not Municipalized in Lisbon?

The reasons for the recurrent conflicts between the administration and the concessionaire confirm the difficulty in designing an efficient regulatory framework and, therefore, sow potential ground for a municipal takeover. The most durable and serious conflict between the state and the company occurred between 1863 and 1867. However, for financial and technological reasons, the 1860s was simply too soon for municipalisation to take place. Firstly, the company would have had to engage in a lengthy judicial process with the municipality in order to receive compensation for the investments already made. Furthermore, urgent work was needed to modernize the water supply that extended far beyond the financial revenues of the municipal council. Resorting to financial markets would become an option after 1880, a period when the municipality made recourse to this channel to fund major works in Lisbon. However, this was not possible in the late 1860s (Silva 2004).

Secondly, the time was not yet right for technological reasons as well. Contrary to other interpretations of the driving impulse generated by positive externalities for municipalisation (see the references mentioned above, notably, Melosi 2000), the main impact of the modern water supply on improving the sanitary conditions arose via the role of water in the sewerage network. The water carriage sewer system did not appear to be a real technological solution in the Lisbon of the 1860s. At the time, every proposal for improving sewage disposal contemplated manual cleaning, without any recourse to water as a draining agent. Any defence of the water-carriage system as a new technology suitable for dealing with sewage problems was absent from the feasible solutions perceived at that time. Only in 1880 did the first project for installing a modern sewerage network become approved for Lisbon (Silva 2006). To sum up, the technological push for municipalisation simply did not exist in the 1860s.

In 1867, the best option for the government and the city council was to reach an agreement that would engage the private company in a programme of significant investments to solve the water scarcity problem in Lisbon. The 1867 concession contract resulted from this agreement. This was responsible for providing the private company with significant incentives to continue its activities for at least the current cycle of the waterworks' lifespan (about 40 years). This new contract also established the means for protecting the private company from future takeovers through providing a long-term economic base. The critical issue introduced was the compulsory connection to the company's water mains in the case of any new building, together with a tightening of the monopolistic supply (independent water-carriers selling water home to home were banned and the number of public fountains was frozen).

The specific economics of water supply are important for understanding how the Lisbon Water Company avoided municipalisation. Water supply depends on access to natural resources such as water sources, as diminishing resources are a logical result of the expansion of the network (Millward 2005: 52). The water supply had not experienced any corresponding trend towards cost reductions driven by

technical progress, as other utilities had at the time (for instance, gas or electricity supply). In order to cope with the rising population and maintain the same standard of service, companies would have to increase investments in distant water sources, extend the pipe networks and potentially engage in more expensive water filtration and purification (see Millward 2005: 51 ff, for these economics). Indeed, to speak about economies of scale in water supply is misleading. What was important was the attainment of the network economies, backed up by the contiguity of potential consumers to the existing piping network.

From this perspective, private water companies critically had to secure a large number of consumers in those streets served by water mains. This represented the best approach to taking advantage of the economies of contiguity in the network and recovering the investment in the waterworks. The functioning of market mechanisms to attract consumers, on a one-to-one basis, would lead to the long-term recovery of investments. The price ceiling in the concession contract prevented any increase in the revenues. The rigid costs did not benefit from any trend towards decreasing due to technical or organizational innovations. This dilemma affected private companies across many cities (Millward 2000 and 2005: 26 ff; Troesken and Geddes 2003; Masten 2010), but was even more pressing in cities of low-income countries such as Portugal.

The solution would arrive with some corrective measure, which might evade the strict market constraints and enlarge the consumer base by administrative means. Compulsory piping was the administrative solution contractually introduced in 1867. From the perspective of the company, this clause constituted the corollary to price regulation. As the government did not guarantee the rate of return, enlarging the consumer base by administrative, and not by market, means was critical to the company, due to the significant investments required by the waterworks to collect water from Alviela. Compulsory piping provided the company with a means to support investment and to attain a comfortable economic and financial position after the 1880s. Every financial indicator aligned to the positive side: a rising number of consumers, the first profits, and the first distribution of dividends. Insulation from municipalisation thus resulted from providing this administrative means of enlarging the consumer base.

The importance of compulsory piping in the enlargement of the consumer base should not be exaggerated. In fact, without an adequate tariff policy, this administrative measure would have failed. The 1867 contract stipulated compulsory piping, but householders were not obliged to become customers and to consume piped water. They could have simply continued to rely on public fountains. As a result of compulsory piping, the number of consumers doubled from 1880 to the end of the century (Silva 2007: Table 8). However, the levels of water consumption per head and per day displayed a constant downwards trend through to the end of the century. Only when a new tariff with a double objective—a minimum level of water consumption and regressive tariffs—was introduced in the 1898 contract revision did water consumption per capita start to grow. The combination of compulsory piping and a new pricing framework fostered the conditions for securing a sizeable number of domestic consumers and a substantial increase in water consumption per household.

The other solution would be municipalisation, as argued by Millward (2005: 53–4): "A great deal of uncertainty therefore surrounded the operation of companies dealing on a one-to-one base with households, some of whom would be reluctant to make the necessary investments. A great attraction of municipal operation was that it involved the finance of water services to households by a water rate, that is, a price related not directly to the volume of household water consumption, but to the value of local property (…). By such a uniform levy, councils automatically enrolled all ratepayers on to the water undertakings' books." Even if tariffs were the pricing method, instead of the water rates based on property value as in Millward's argument, municipalisation would use administrative means to enlarge the consumer base. After integrating water and sewerage networks under the same management, the administrative enforcement of a household connection to the municipal water network would be justified by the need to access the vital means for leveraging the technological advantage of the modern sewage disposal technique.

8 Conclusion

This chapter seeks to participate in the debate on the reasons for the municipalisation movement across late nineteenth century European and North-American cities. At a time when liberalism was influencing economic policies, and with the state retreating from direct intervention in economic activities (Sutcliffe 1982), the urban context became more than a laboratory for public management. The mass movement to take over water utilities, as well as the similar, although less intense, push in urban transportation and energy supply, represented more than separate experiments. "The urban variable" explained this propensity for increasing levels of state intervention in different fields of urban life, from utilities to the environment (Silva 1994; Silva and Sousa 2009). Urban agglomerations were, in different ways, catalysts of positive and negative externalities, demanding different types of public intervention. One of these was a clear trend for the public ownership and management of waterworks in the wake of several decades of arm's length regulation.

Asking why Lisbon failed this trend towards water municipalisation reverses the initial question about the reasons for the municipalisation movement. Flipping the question is, nevertheless, similarly relevant, and perhaps even more illuminating. This may lead the argument through different but clearer perspectives, in a similar way to deploying counterfactual questions and arguments for dealing with research conundrums.

The absence of any water supply municipalisation in Lisbon did not result from any atavism regarding state intervention in urban affairs. This absence becomes even more surprising when one considers that late nineteenth-century Lisbon had experimented with urban planning through the expropriation of land (Silva 2004). This represents one of the most radical models of urban land management, with the

municipality acting as a developer: firstly, expropriating large tracks of land, and then building public infrastructures on the ground prior to the sale of lots to builders.

In Lisbon, the absence of municipalisation stems from two main reasons, which thus also testify to why this occurred in other urban contexts: the technological integration between the water supply and sewerage networks and the high transaction costs posed by the regulatory regime for private water companies. These reasons were not unique in the sense of excluding the impact of other motives. The combination of social and political environments conducive to greater public intervention in urban affairs, as well as the financial and political autonomy of city councils, also played a role in nurturing conditions more favourable to municipalisation.

The literature on the evolution of sanitation technology has argued convincingly in favor of the interdependence between water supply and the technological solution for sewage disposal problems. This argument fails to appear in the debate on the reasons for municipalisation. When positive externalities are proposed, they emerge from the failure of private companies to provide adequate quality and socially inclusive piped water. The interconnection between water and sewerage was the most important source of positive externalities in the water supply and contributed to raising municipalisation as a potential solution for the shortcomings of private provision.

However, the externalities argument, based on the interconnection between water and sewerage networks, would not inexorably lead to municipalisation. An effective regulatory regime based on contractual agreements and constant overseeing by administrative bodies, similar to those existing in Lisbon following the 1867 contract, might attain the objectives of providing universal access to water, maintaining the profitability of the private undertakings, and preventing abuses of monopolist positions. In theory, public subsidies might also support access to private water provision by poor households. However, the efficiency of any regulatory regime for supervising private water companies turned out to be an illusion. Recurrent conflicts and bargaining manoeuvres, whether from the company or the municipal council, constantly contaminated relations between regulator and concessionaire.

Internalisation is a typical alternative to contracts when there are situations of high transaction costs and externalities (Coase 1937; Williamson 1975). Internalisation occurs whenever public ownership and management took over water supply networks. Consolidating the water supply and sewerage networks under public management would appear to solve the high transaction costs incurred in relations between private concessionaire and administration. Internalisation and consolidation under the same managerial authority would cope with the high transaction costs related to the regulation of the water component in the water and sewerage system.

Managerial consolidation under public ownership would also provide a solution to another issue besetting private water networks. The water supply did not have economies of scale, but rather economies of contiguity. Rapidly increasing the number of households connected to the water mains on any given road would

represent the best mechanism for recovering capital investment and attaining an average rate of return for private investors. Concessionaire companies relied on the atomistic capture of consumers, based on one-to-one decisions to contract the piped water supply service. This atomistic process was slow, spread across the area served by the private concessionaire, and plagued by uncertainty. Municipal ownership of waterworks could mobilise administrative means for enforcing connections for every household to the water network. Other administrative apparatuses, such as building codes, the establishment of household water pipes and connections with the water and sewerage networks, could then also be mobilised to enforce standards and practices. Even while relying on tariffs (and not on taxes or rates), the public company might design a tariff regime based on a low, flat rate for domestic consumers with low consumption patterns and regressive tariffs for more affluent or business consumers. In this way, the desideratum of universal coverage could be rapidly attained, simultaneously permitting a more rapid amortisation of capital costs. Furthermore, the ultimate aspiration of enlarging the consumer base would also be accomplished.

In Lisbon, private management persisted, but based on an administrative device to recover sunk costs and insulate the company from municipalisation. Compulsory piping acted as an administrative solution to attaining a large consumer base, thus allowing the company to benefit from the economies of contiguity outlined above. This did not end the conflicts or the bargaining between the company and the administration. However, it strengthened the financial position of the company when finally implemented. The substantial increase in the volume of water after 1880 occurred in simultaneity with this implementation. The large volume of piped water flowing into the city encountered the administrative mechanism that created the consumer base that it needed.

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