

Franchise Bidding in the Water Industry – Auction Schemes and Investment Incentives

Urs Meister*

April 18, 2005

Abstract

The periodical re-auction of a water monopoly concession causes the danger of underinvestment. If the life-time of specific assets such as water pipes exceeds the contract length and transferring the ownership of assets is difficult, the incumbent franchisee faces a hold-up problem. Using a simple auction model that considers the specifics of the piped water sector this paper shows that investment incentives may vary depending on the applied auction scheme. The model is designed as a two stage game, where the franchisee decides about investment on the first and competes with a potential market entrant on the second stage. Investment tends to be higher in sealed bid auctions than in an English auction, since the incumbent benefits from an information advantage. Additionally investment may vary in a first- and a second-price sealed bid auction depending on several factors such as costs or effectiveness of investment. The analysis is extended by a vertical separation.

Key Words: Water, Networks, Franchise Bidding, Investment

JEL Classification: L95, L43, D21, Q25

* University of Zurich, Institute for Strategy and Business Economics, Plattenstrasse 14, CH-8032 Zürich, Tel: +41-1-634 29 62, Fax: +41-1-634-43 48, email: urs.meister@isu.unizh.ch.

** Thanks to Men-Andri Benz from the University of Zurich and Reto Foellmi MIT, Department of Economics, Cambridge MA for helpful comments.

1. Introduction

Due to extensive shares of fixed costs network industries such as electricity, gas, railways or water are widely seen as natural monopolies. In such case it is cost minimising and therefore socially wanted when only one single firm serves the entire market. Usually these services are rendered by public enterprises or strongly regulated private companies. Harold Demsetz (1968) proposed franchise bidding as an alternative to regulation. He argued that auctioning the rights to a natural monopoly would lead to a similar outcome as regulation, but at lower costs. In fact franchise bidding has often been used in practice. But there is only some experience in the water sector – mainly from France. The success of the auctioning model in the French water sector is assessed ambivalent since competition at the re-auctioning stage is only minor intensive. However, in theory the main criticism of Demsetz' proposal rather concerns investment incentives than competition intensity. It was Oliver Williamson (1976) who pointed out the problem of long-term specific investments. If the life-time of specific assets exceeds the contract length and transferring the ownership of assets is difficult the franchisee faces a serious hold-up problem. As a result re-auctioning a natural monopoly undermines investment incentives. The hold-up problem tends to be stronger in sectors where investment is very specific, long term oriented and hardly to evaluate by a third party. One can assume that investment in the capital-intensive water sector exactly corresponds to these characteristics. Water pipes have technological lifetimes up to 100 years and they can not be dug out and used elsewhere. Additionally investment into the underground network can hardly be monitored by a third party. However, if an incumbent franchisee is able to pretend higher investment and to receive higher compensation in case of loosing the re-auction process he has an advantage in the re-auctioning stage. Armstrong et al. (1994, p, 129) follow: "If Investment in specific assets is important, as in major parts of the utilities there is a serious danger either of underinvestment or of

ineffective competition for franchise”. And they conclude that franchise bidding is not useful for capital-intensive natural monopolies. One should have in mind that investment into the pipe network plays an important role in the capital-intensive water industry. Up to 90 percent of total costs in the piped water industry concerns investment into the network. However, in many European countries investment has been widely neglected due to the municipality’s financial restrictions. As a result water losses in different networks amount up to 50 percent of total water production.

After discussing the background of specific investment in procurement auctions and some auction theory in Section 2, we introduce a simple model which examines investment incentives in an auctioned water monopoly. The model presented in this paper basically examines an incumbent franchisee’s investment incentives. The model assumes that investment into the pipe network reduces water losses in a pipe network and therefore total costs of water production. Additionally investment is *i)* long term oriented, *ii)* very specific and *iii)* not verifiable. Section 4.2 varies the duration of the concession contract. Obviously investment incentives are stronger in a long term contract, since the hold-up problem tends to be less intensive. Section 4.3 introduces a re-auctioning procedure and investigates investment depending on different auction schemes such as a first-price sealed bid auction, second-price sealed bid auction and the English auction. Such analysis uses a game theoretic approach. On a first stage of the model the incumbent player decides about the amount of investment, on the second stage the incumbent competes with a potential market entrant in the auctioning procedure. The model can be solved by backwards induction. Using a common value auction scheme where the incumbent has superior information about its past investment and therefore future production cost one can show that investment incentives differ in these auction schemes. However, investment tends to be the lowest in the English auction scheme, where the concurrent bidder is able to observe the incumbents bidding behaviour. In Section 4.4 the model is extended by assuming vertical

separation. And Section 5 investigates additional aspects which are relevant in different auction schemes. Such aspects concern political sustainability, the hazard of the winner's curse and opportunities of collusion amongst bidding firms.

Some literature examines investment incentives in procurement auctions. One main paper was written by Tan (1992) who analysed R&D investment. He showed that in case of simultaneous investment and ex-ante symmetric firms investment incentives are equal for all participants. Furthermore firms' investment incentives do not differ in first and second price auctions. Laffont and Tirole (1993) analyse investment in repeated auctions and show that investment can be improved by giving preference to the incumbent in the re-auction. The case of heterogeneous firms was investigated by Arozamena and Cantillon (2000). In their model firms invest in pre-auction investment in order to improve their relative position in the procurement auction. They show that in the first price sealed bid auction firms tend to underinvest since they anticipate stronger competition afterwards. Tolga Yuret (2004) examines the auction design problem when bidders invest before the auctioning process in order to increase the expected valuation. He shows that in equilibrium none of the bidders invests when the auctioneer is not able to commit to an auction scheme before the bidders invest. However, our model applies basic auction theory to the water sector's specific problems. In contrast to most papers above, there is only one bidder – the incumbent – investing before the auction takes place.

2 Theoretical background

2.1 Franchise Bidding and specific investment

According to Demsetz's proposal in his famous article "Why Regulate Utilities" (1968) firms bidding for a natural monopoly do not specify the

purchase price they are willing to pay. Instead they are required to define the per-unit price they would charge for the relevant product or service at given performance parameters. The company promising the lowest price gets the exclusive right to serve customers in the defined area. With enough bidders it is expected that a bidder reveals his minimum costs and offers a price, which “differs insignificantly from the per-unit cost” (Demsetz 1968, p. 64). Such average cost price is expected to be lower than the profit-maximising monopoly price¹. Demsetz pointed out that the resulting prices from the auction procedure are a result of the competition at the auctioning stage instead of regulation. In a world of perfect information and efficient contracts the role of the government can be reduced to the organisation of the auction – ex post price regulation would not be necessary. However, in practice both information and contracts are fairly incomplete. One might conclude that franchise bidding is expected to be less efficient than predicted by Demsetz. It was in particular Oliver E. Williamson (1976) who pointed out the problem of specific investments in long term franchising contracts. It is supposable that the actual terms of a franchising contract do not count for all possible states in the future. Contractors are not able to anticipate all circumstances that require a modification of the original terms such as the relevant per unit price. In order to prevent unwanted welfare impairments the governmental authorities can re-auction the monopoly periodically². However, Williamson indicates that re-auctions combined with shorter holding periods undermine the incumbent’s incentives to invest in durable specific assets. Due to their specificity assets cannot be used elsewhere and are hardly tradable. Williamson argues that in order to maintain investment

¹ Lester Telser (1969) objected that the maximisation of social welfare requires marginal cost pricing. Average cost pricing induces only a second-best solution. However, such solution assures that the winning firm does not need subsidies to cover entire costs. In order to enforce a first-best solution, bidders could alternatively be required to offer a two-part tariff. The regulator chooses the firm which maximises social welfare. However, to choose such first-best solution the regulator would need exact information about demand (see Viscusi et al. 1998, p. 418).

² Of course such problem could basically be solved by the renegotiation of the contractual terms. However, Richard A. Posner (1972, p. 115) argues that a regulator is not expected to represent consumers’ interest in such renegotiations adequately. He rather recommends re-auctioning the monopoly periodically.

incentives “some method of transferring assets from existing franchisees to successor firms plainly needs to be worked out” (Williamson 1976, p 85). A basic rule was already proposed by Richard A. Posner (1972, p. 116): An incumbent franchisee is required “to sell his plant (included improvements) to the latter at its original costs as depreciated”. Williamson argued that Posner declines to supply the “troublesome details” of such rule. In order to use such rule in practice, sufficient accounting data must be available and physical depreciation must be measured adequately. But due to asymmetric information an incumbent firm may be able to manipulate such data: While the franchisee itself is able to evaluate its assets accurately, outsiders such as competitors or regulators can not observe and verify past investment behaviour properly. Furthermore Williamson remarks the hazard of inflated equipment prices when a franchisee is integrated backwards into equipment supply or when kickbacks are paid. The more informed incumbent firm may successfully pretend an oversized investment level and obtain a significant advantage at the contract renewal interval. Re-auctioning the monopoly therefore causes not only the danger of underinvestment but also the hazard of lacking competition at the auctioning stage.

Based on Williamson’s critique Jean-Jacques Laffont and Jean Tirole (1993) developed a theory regarding optimal re-auctions in case of specific but transferable assets. They assume that the incumbent’s specific investments can not be observed and verified by a regulator. In order to maintain the incumbent’s investment incentives Laffont and Tirole recommend a re-bidding scheme that gives preference to the incumbent. However, such rule implies a break with the principle of bidders’ parity in auctions. One might concern about the practical implementation of such rule, since a regulator should assess the relevant “preference for the incumbent”. Michael Klein (1998/b, p. 3) recommends an auction scheme that restricts the regulators’ discretion. The regulator should define *before* the auction that another bidder wins only if it underbids the incumbent’s offered per-unit price by – for example – more than 10 percent. Yet in

practice such discount-rule has been used in several auctions – in particular in water concession auctions in France. Klein (1998/b, p. 4) complains that such rules usually meant that water concessions are just re-awarded to the incumbent.

2.2 Auction schemes

Before examining the relation between auction schemes and investment incentives in the water industry in section 4 it is useful to give a brief survey of auction schemes that can be used for franchise bidding procedures. Such survey is given by several authors such as McAfee and McMillan (1987), Milgrom and Weber (1982), Engelbrecht-Wiggans (1980), Milgrom (1989), Rothkopf and Harstad (1994) or Becker (2001). Auction theory suggests four basic schemes³: The English auction, the Dutch auction, the first-price sealed-bid auction and the second-price sealed bid auction. Both the English and the Dutch auction are open auctions. Bidders traditionally gather at one place to bid, whereby they are able to observe other's bidding behaviour. In the English auction scheme the auctioneer raises the price incrementally. Bidders decide if they are still willing to pay the actual price and continue participating in the auction. The auctioneer stops raising the price when only one bidder remains. The winner has just to outbid the second highest bid. In case of infinite small incremental price steps, the price to be paid equals the second highest valuation. The Dutch auction is organised reverse: The auctioneer reduces an initially defined price incrementally. The first bidder who signals willingness to pay receives the auctioned good – the price equals its own bid. Sealed bid auctions do not offer participants to observe their concurrent bidders. In the first-price sealed bid auction bidders submit sealed bids. The highest bidder is awarded the item for the price he bid. The second-price sealed bid auction is basically organised similar. But the price

³ All of these auction schemes give preference to the bidder with the highest willingness to pay, e.g. the one who offers the highest price for a good. Of course these schemes can easily be transformed into an auction scheme that gives preference to the bidder that offers the lowest per-unit price.

to be paid equals the second highest bid. Such rule was proposed by William Vickrey (1961).

	<i>First-price</i>	<i>Second-price</i>
<i>Open</i>	Dutch	English
<i>Sealed</i>	First-price sealed bid	Second-price sealed bid

Table 1: Auction rules

The bidder's strategies may differ depending on the available information about the value of an auctioned good and on the information about other bidder's valuation of the good. Standard models in auction theory assume independent private values where each bidder knows exclusively his own value for the good and the bidders' valuations are statistically independent. In such setting the bidders' strategies in the English and the second-price sealed bid auction are equivalent: competing up to the maximum valuation is a dominant strategy for all bidders. Furthermore bidder's strategies in the Dutch and the first-price sealed bid auction are equivalent: bidders face a trade off between losing the auction against the profitability of winning. Bidders will therefore not reveal their maximum valuation (see Rothkopf and Harstad 1994).

In real auctions it might be necessary to weaken the assumptions regarding independent valuation. Common value models assume one "true value" of a good. Bidders estimate this value based on similar common random factors they observe. One can therefore assume that valuations must be positively correlated. Milgrom (1989, p. 13) points out, that such setting is applicable especially in auction models for oil and gas drilling rights or for wine and art. In these cases bidders face a common uncertainty about the value. Milgrom and Weber (1982) introduced a model with *affiliated values*. Their model has independent private values as one polar

case and common values as another. They showed that open auctions offer bidders to gather more information about the value since they allow to observe others bidding behaviour. As a result the English and second-price auctions are not equivalent. Due to the additional information bidders tend to be more aggressive in the English auction. However, the Dutch and the first-price auctions are still strategically equivalent.

3 The piped water industry

3.1 The role of investment

The distribution network is the main cost driver in the piped water industry. Up to 90 percent of water utility's total costs are related to network investment and maintenance (see Skarda 1998, p. 867). Water pipes have a technological life-time that ranges from 50 to 100 years – depending on their material. Main pipe damages are caused by corrosion since the largest part of the network consists of cast iron pipes. In order to maintain the network and to minimise water leakage utilities are required to renew their network continuously. The International Water Service Association (IWSA) recommends a yearly turnover rate of 1.5 percent – which means utilities are required to replace 1.5 percent of their network. In fact turnover rates are far lower and amount to an international average of about 0.6 percent (see Skarda 1998, p. 867). As a result water leakage rates in the network systems are significant and amount up to 50 percent of total water production in some areas. In Spain the average leakage rate amounts to 30 percent, in England and Wales to 29 percent, in France to 25 percent, in Germany to 9 percent and in the Netherlands to 3 percent (see EEB 2002, p. 29). The cost of water leakage equals the relevant water production costs, since water has to be treated *before* introducing it into the pipe network. Costs therefore depend on the quality of used raw waters and the relevant

treatment requirements. As a result water leakage tends to be less expensive in regions with high quality raw water resources such as spring or ground water. It is more expensive in regions where surface water is used, which has to be treated more extensively and therefore costly (see Dwr Cymru Welsh Water 1999, p. 9). On a quantitative basis the extent of water leakage for a given pipe length and time period is determined by two factors: the consistency of the pipe network on the one side and water pressure in the pipe network on the other side. Water utilities can influence the pipe consistency by network investment. A higher renewal rate increases network consistency and reduces water leakage. Water pressure in the pipe network is given by factors such as topography, network extension or the location of water treatment and storage facilities. Utilities have to ensure a permanent minimal operating pressure in order to satisfy customer needs.

A further role for investment is the extension of supply capacities. Such investment may concern treatment and storage facilities on the one side and pipe networks on the other side. However, in practice capacity extensions today play a minor role in many developed countries since per capita water consumption significantly declined during the last 15 years – mainly due to technical inventions and changed industrial structures. In Germany for instance per capita consumption declined about 13 percent between 1990 and 2001. At the same time water utilities extended their capacities significantly during the seventies and eighties in exception of an increasing demand. Prognoses assumed a daily per capita household consumption of 219 litres in 2000. In fact consumption amounts to 136 litres (see BGW 2004). Similar trend occurred in other European countries, e.g. Switzerland. Daily household consumption amounted to 162 litres in 2003 – in 1982 it was 182 litres. Within the same period total per capita consumption declined from 500 to 391 litres (see SVGW 2003, p. 1).

Investment into the water pipe network is assumed to be very specific. Michael Klein (1998/b, p. 1) emphasises that “water pipes normally cannot be dug out and used elsewhere economically”. Since water pipes can

not be used alternatively the relevant costs can be assumed to be sunk (see Furrer 2004, p. 24). Furthermore it is obvious that a fair and true evaluation of a water utility's network assets must be difficult. Since pipelines are in the ground, it is not possible to assess the quality of the water pipelines (see Klein 1998/b, p. 2). Even when exact data about the age and the structures of the network are available, it would be difficult to assess the consistency and therefore the value of the network assets. The technological life-time of pipes vary significantly and depends on several factors such as material of pipes, soil conditions, parasitic current or other external impacts (see Skarda 1998, p. 871).

3.2 Franchise bidding in the water industry – evidence from France

Obviously network investment in the piped water industry is highly specific and very long term oriented. In a re-bidding procedure for a franchised water monopoly one can expect a serious hold-up problem as described in section 2.1. Since investment into underground assets can not be observed and verified exactly by a third party, there is a serious danger of underinvestment or ineffective competition. Michael Klein (1998/b, p. 3) follows, that re-bidding for a water concession “will remain the toughest challenge” since underground pipes are the hardest to inspect. Nevertheless, many water sector reforms in practice used franchise bidding as a way of introducing privatisation and competition into the piped water industry. Major experience in auctioning water monopolies has been made in France. At the beginning of the 19th century large cities such as Paris, Marseille or Lyon already called private companies to make infrastructure investments in exchange for the right to manage them. The process of delegation and privatisation strongly continued in the second half of the 20th century. Today more than 75 percent of total population in France is served by private

water companies (see Clark and Mondello 2000, p. 326 and Hemmer et. al. 2002, p. 12).⁴

The extent of private involvement in water supply varies significantly between municipalities. Elnaboulsi (2001) differentiates four basic types of delegation: Management Contracts (*Gérance*), *Régie Intéressé*, Leasing (*Affermage*) and Franchise (*Concession*). This paper focuses Leasing and Franchise where the entire water supply is delegated to one company⁵. Under the Leasing contract the private company is responsible at its own risk for provision of the water service, including operating and maintaining the infrastructure and charging water fees to customers. But investments into pipe network and treatment facilities are rendered and financed exclusively by the municipality; the private company pays a fee for using the infrastructure. Under the Franchise contract the private company is additionally responsible for financing and carrying out the investments that are required to meet the relevant obligations fixed in the contract or defined by a regulator. At the end of the contract period the incumbent can be compensated if investment is not fully amortised.

	<i>Leasing</i>	<i>Franchise</i>
<i>Financing operations</i>	Private	Private
<i>Financing investment</i>	Public	Private
<i>Duration of concession</i>	20 years	10 – 12 years

Table 2: Delegation contracts (see Elnaboulsi 2001, p. 536)

⁴ Since recent years franchise bidding has also been applied in other countries such as Italy, Hungary, Argentina, Bolivia, Manila, Morocco, Colombia, or Senegal.

⁵ Both Management Contracts and *Régie Intéressé* use a relative low level of private sector involvement, where a private company operates only specified parts of the water supply system. Under the Management Contract the company charges a fixed fee for its service, under the *Régie Intéressé* the relevant fees depend on efficiency.

In both delegation models the municipality auctions the right to serve water supply to a private company. Usually the auction procedure contains two major steps. In a first step the auctioneer evaluates financial and technical capabilities of potential bidders. Firms that meet the auctioneer's requirements are allowed to make concrete tenders in the second step, where the main evaluation criterion is the offered per-unit price. The second step basically refers to a first price sealed bid auction. However, municipal authorities are free to negotiate with bidders and to choose the preferred company – based on several criteria beside per-unit price (see Furrer 2003, p. 216).

The success of franchise bidding in the French water sector is assessed ambivalent. One main criticism is the lack of competition at the auctioning respectively the re-auctioning stage. In its 1997 report the French national audit court (Cour des Comptes 1997) identified a lack of competition, a lack of transparency and excess pricing. The report emphasised in particular the repeated use of the negotiated procedure, nearly always with the same companies and a tendency to extend existing contracts without subjecting them to tender. Additionally cases of bribery and corruption occurred. Municipalities awarded concessions to companies that paid *entry fees*. Municipal authorities used these payments to improve their budget situation.⁶ Additionally the audit court stated the widespread renegotiation of original contract terms. Incumbent firms often renegotiate franchising contracts ex post in their favour. Asymmetric information and costs of re-awarding the monopoly to another firm give the incumbents significant bargaining power in this process (Cour Des Comptes, 1997, p 125). Water tariffs vary significantly between French municipalities. On average prices are 30 percent higher in case of private supply. However, higher prices are not only a result of lacking competition. Private companies tend to supply more problematic and therefore costly areas. Additionally

⁶ One main example is Grenoble, where the private company Cogese paid entry fees worth FF 226 millions. Cogese recovered these costs through charging higher tariffs to water users (see Hall and Lobina 2001, p. 6)

investment into infrastructure tends to be more continuous than in public served areas (see BMWi 2000, p. 16).

Since recently the French government tries to improve the degree of competition in the water industry. As some major steps it limited the duration of franchising contracts and forbid the practice of entry fees (see Furrer 2003, p. 208). Obviously such measures tend to limit the market power of incumbent franchisees. However, increased competition undermines the incumbent's incentives to invest in specific assets. One can expect that in the near future the French water industry will increasingly face the trade off between competition and investment incentives.

4 A simple model

4.1 The model's design

Since investment into the pipe network can not be observed and verified properly by third parties contracts between the public body and a private franchisee concerning the amount of investment are expected to fail. Sufficient investment can not be guaranteed by a contract or regulation. In this case the public body has to consider a franchisee's investment *incentives* when arranging a franchise bidding procedure and writing the relevant franchise contract. The following model basically assumes a Franchise contract between a private franchisee and the public body, where the private firm is responsible for carrying out and financing the investment. We extend the model in Section 4.4 by introducing vertical separation of infrastructure investment and infrastructure operations. The time frame of the model consists of two periods. In the first period water supply and network investment is carried out by an incumbent firm *A*. The chosen investment determines the consistency of the pipe network and therefore water leakage in the first *and* the second period – since investment is assumed to be long-

term oriented. In the second period water supply is provided by the incumbent firm A again, or by an entrant B . In our analysis we focus the incumbent's investment behaviour in the first period – investment in the second period is not of interest and can be ignored. Figure 1 outlines the basic design of the model:

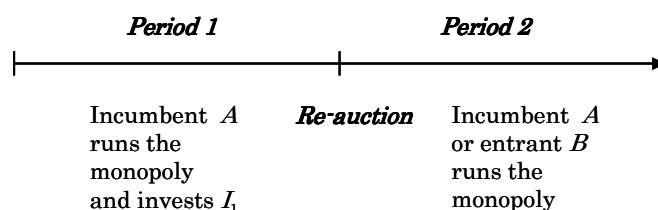


Figure 1 : Time frame of the model

In order to keep the analysis simple, the model assumes a fixed demand for treated water in both periods. Elasticity of demand is therefore assumed to be zero in the relevant range. Such assumption might be appropriate, since effective demand elasticity in the urban piped water sector tends to be very inelastic.⁷ There is a common knowledge about market demand q_1 respectively q_2 . The quantities q_1 and q_2 can be different.

A water supplier's costs consist of treatment costs C on the one side and investment costs K on the other side. We omit further administrative costs since they are not relevant in our analysis. Water treatment costs are increasing in the production quantity, which is determined by sold water and water leakage. As explained in section 3, the amount of water leakage for a given pipe length and time period depends on the consistency of the pipe network on the one side and water pressure in the pipe system on the other side. In this model water pressure is exogenous. The consistency of the

⁷ Dalhuisen et. al. (2000) analysed 70 studies, which contain 241 estimates on water demand. According to their meta-analysis the distribution of estimated price elasticities has a mean of -0.51 and a median of -0.41. About 15 percent of the estimates have a price elasticity of about 0.

pipe network depends on the extent of investment. Water treatment costs in period one can be defined as follows:

$$C_1 = C_1(q_1 + L_1(I_1)) \quad (1)$$

C_1 stands for total treatment costs in period one, q_1 for the quantity of billed water, L_1 for the amount of water losses in period one and I_1 for investment in period one. Since investment into the pipe network can not be observed and verified by a third party, the franchisee can not expect to be compensated adequately in case of loosing the re-bedding procedure. Costs of investment are therefore sunk.⁸ It is reasonable to assume, that the life time of network assets exceed the Franchise contract length.⁹ One can therefore assume that water leakage and therefore treatment costs in the second period are as well affected by first-period investment:

$$C_2 = C_2(q_2 + L_2(I_1)) \quad (2)$$

Since any supplier would use the same infrastructure in the second period, both suppliers A and B would face similar treatment costs C_2 . Water treatment costs increase in production quantity. Since both billed water and water losses have to be treated before introduced into the pipe network, we can define $\partial C_i / \partial q_i = \partial C_i / \partial L_i > 0$ where $i \in \{1, 2\}$. Obviously the investment tends to reduce water leakage stronger in the first period than in the second period – the older the assets, the higher the leakage. Therefore: $\partial L_1 / \partial I_1 < \partial L_2 / \partial I_1 < 0$. As a result water treatment costs are decreasing in investment, $\partial C_i / \partial I_1 < 0$. Additionally we can assume that $\partial^2 C_i(I_1) / \partial I_1^2 < 0$.

⁸ One could alternatively assume that the incumbent and a regulator negotiate about the compensation. However, in such case the resulting compensation would rather reflect bargaining power than actual worth of investment. The compensation is then assumed to be exogenous since it is not explained by the model. Such assumption would not change any results.

⁹ In France the duration of Franchise contracts amounts to a maximum of 30 years. The technical lifetime of network assets varies between 50 and 100 years.

Beside treatment costs the water supplier A faces costs of investment in the first period. We define such costs as follows:

$$K_1 = K_1(I_1) \quad (3)$$

Costs of investment are increasing in the amount of Investment, $\partial K_1 / \partial I_1 > 0$. Additionally we assume that investment costs increase at an increasing rate, $\partial^2 K_1 / \partial I_1^2 > 0$. In the following sections we examine A 's investment incentives in the first period. In section 4.2 we analyse the influence of the contract length. In 4.3 we introduce a re-auction procedure after the first period and compare investment incentives in different auction schemes. In Section 4.4 we analyse the player's participation incentives in the auctioning stage and in 4.5 we extend the model by allowing for firm specific efficiency differentials. Section 4.6 extends the model by assuming vertical separation of operations and investment according to a Leasing contract.

4.2 Long-term versus short-term contracts

Investing into the pipe network allows the incumbent A to reduce the extent of water leakage and therefore production costs in the first *and* the second period, since investment into the pipe network can be assumed to be long-term oriented. A therefore faces a hold-up problem when the relevant contract period is short term. A 's profit maximising problem from running the water monopoly only in the first period can be defined as follows:

$$\max_{I_1} p_{1A} q_1 - C_1(q_1 + L_1(I_1)) - K_1(I_1) \quad (4)$$

where p_{1A} denotes A 's per-unit price in period one. The price can be seen as exogenous because it results from the initial franchise bidding procedure at the beginning of period one. Since we assumed that costs of investment

$K_1(I_1)$ are sunk, A is not compensated for its past investment at the end of the contract period. One can easily derive the optimal investment level by using the first order condition:

$$\frac{\partial K_1}{\partial I_1} = - \left(\frac{\partial C_1(\cdot)}{\partial L_1} \frac{\partial L_1}{\partial I_1} \right) \quad (5)$$

A equals marginal costs and marginal benefits from investment. Such benefits arise due to a reduction in total treatment costs in period one. Benefits of the investment are denoted by the left hand side of equation (4). However, the incumbent A does not take into account any positive effects from cost-reducing investment in period two. A welfare-maximising regulator would rather require the equalisation of marginal costs and total marginal benefits from both periods. A profit maximising firm that runs the monopoly in both periods would meet such requirement:

$$\max_{I_1} p_{1A}q_1 - C_1(q_1 + L_1(I_1)) - K_1(I_1) + \delta [p_{2A}q_2 - C_2(q_2 + L_2(I_1))] \quad (6)$$

where δ denotes the discount factor. Again one can derive the optimal investment level by using the first order condition:

$$\frac{\partial K_1}{\partial I_1} = - \left(\frac{\partial C_1(\cdot)}{\partial L_1} \frac{\partial L_1}{\partial I_1} + \delta \frac{\partial C_2(\cdot)}{\partial L_2} \frac{\partial L_2}{\partial I_1} \right) \quad (7)$$

It is easy to show that direct investment incentives are higher in the two-period monopoly, since the right hand side of equation (7) exceeds the right hand side of equation (5). Obviously the hold-up problem can be removed by exceeding the contract period. However, as mentioned in section 2.1 the regulator faces a trade off between keeping direct investment incentives and degree of competition. Exceeding the contract period and leaving the re-

auctioning stage remove competition and therefore the potential for price reductions. Net-welfare effects of a longer contract period can be negative if technical progress or other external effects reduce production cost. Nevertheless, since demand is assumed not to be varying in retail prices, the amount of investment always corresponds to the social optimum. Since we focus investment behaviour, we can use the resulting investment incentives given by equation (7) as a benchmark in the following.

4.3 Re-auctioning the monopoly

In order to limit the incumbent's potential market power the regulator can re-auction the monopoly after the first period. The re-auction of the concession can basically be designed as a two stage game. In a first stage an incumbent franchisee chooses the amount of investment which determines actual and future water leakage. In the second stage a regulator re-auctions the water monopoly. The model assumes two risk-neutral bidders, the incumbent company A and a potential market entrant B . In order to define their bidding strategies in the re-auction process both the incumbent A and the entrant B need to forecast average treatment cost $C_2/q_2 = c_2$ in the second period.¹⁰ As mentioned above, both water suppliers A and B would use the same pipe network in the second period. As a result they would face similar treatment cost c_2 after winning the re-auction – if we abstract from firm specific efficiency differentials. However, the model assumes asymmetric information about the investment level and therefore about water leakage and treatment costs in the second period. Obviously the incumbent firm A faces an information advantage, since it knows the extent of its past investment exactly. In our model we assume a perfectly informed incumbent A that assesses average production cost in period two exactly at c_2 . However, the less informed player B can not observe c_2 . Therefore B is

¹⁰ In their tenders bidders have to define the per-unit price they would charge to customers. Since bidders do not want to generate losses, they compare the per-unit price with average costs. An optimal bidding strategy requires a per-unit price which is increasing in average costs.

not aware of true costs. In order to prepare its price bid in the auction process, B makes a cost estimate c_{2B} . From the incumbent's perspective B 's cost estimation is a random variable c_{2B} with a uniform distribution on $[0, \bar{c}]$ as presented in Figure 2. We assume that actual costs c_2 in the second period are in the range of 0 and \bar{c} . The cost maximum \bar{c} would result at zero investments in period one. The distribution is *not* assumed to be common knowledge among both bidders.

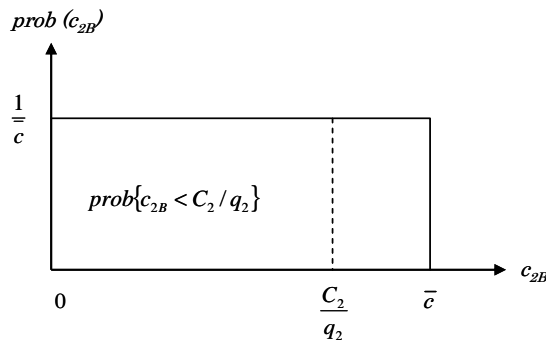


Figure 2 : The distribution of B 's average cost estimation

One might complain that using a backwards induction could allow B to anticipate A 's optimal investment level I_1^* and therefore actual average production costs. However, we assume that B does not have any information about the relevant starting point: B does not know about the pipe network's initial consistence and therefore about A 's true treatment costs at the beginning of period one. In such case B is not able to anticipate A 's investment behaviour and therefore the average production cost in period two. In addition there might be other sources of uncertainty: Costs may differ between A and B due to different labour productivity. However, the model represents a reduced form and abstracts from such additional sources of uncertainty. We summarise that A does expect that B is not able to observe or to anticipate I^* .

In the following sections we analyse A 's auctioning and investment behaviour under different auction regimes. For this purpose we assume A 's and B 's participation in the auctioning procedure as exogenously given. Such assumption is useful, since up to this point we did not allow for firm specific efficiency differentials. However, we extend the analysis in section 4.4 where we make the participation decision endogenous and when we allow for firm specific efficiency differentials.

4.3.1 First-price sealed bid auction

For concessions it is the standard to use a first-price sealed bid auction (see Klein 1998/a, p. 1). Bidders submit a sealed envelope to the regulator. The monopoly is awarded to the bidder with the lowest per-unit price. In order to examine the incumbent's investment incentives we solve the model by backwards induction. In the second stage of the model A and B compete in the re-auctioning process. Therefore we firstly analyse their competitive behaviour which determines the relevant per-unit price in the second period on the one side and the probability of winning the auction on the other side. Afterwards we analyse the first stage of the model where the incumbent decides about its investment into the pipe network.

The incumbent A wins the first-price sealed bid auction when the offered price p_{2A} is lower than p_{2B} offered by entrant B et vice versa. In a first-price sealed bid auction both bidders face a trade off between maximising the probability of winning the auction and maximising the relevant profit margin (see Becker 2001, p. 6). Obviously the bidders' lowest possible bids equal forecasted average costs c_2 respectively c_{2B} – otherwise the outside option is more attractive. Bidding a price equal to average costs maximises the bidder's probability of winning the auction. However, a price above average costs increases the payoff when winning. Since the offered price is expected to increase in average costs, we can define the bidder's price strategies as $p_{2A} = p_{2A}(c_2)$ respectively $p_{2B} = p_{2B}(c_{2B})$. We follow

Rothkopf (1969) and simplify the exposition by assuming that players only choose multiplicative strategies. Such strategies are defined as follows: $p_{2A} = \alpha_A c_2$ and $p_{2B} = \alpha_B c_{2B}$, where $\alpha_i \geq 1$ is the “mark-up multiplier”. Now we can write the necessary condition for winning the auction. The incumbent firm A wins the auction when $p_{2A} < \alpha_A c_{2B}$ or

$$\frac{p_{2A}}{\alpha_B} = \frac{\alpha_A c_2}{\alpha_B} < c_{2B} \quad (8)$$

Firm A therefore faces the following maximisation problem:

$$\max_{\alpha_A} E \left[(\alpha_A c_2 - c_2) \text{prob} \left(\frac{\alpha_A c_2}{\alpha_B} < c_{2B} \right) \right] \quad (9)$$

When maximising the expected profit bidder A not only take its own costs into account. Obviously A considers B 's mark-up multiplier and therefore B 's cost forecast. From equation (9) we know that the rival's cost forecast c_{2B} affects the probability of winning the auction. A believes that c_{2B} is uniformly distributed on $[0, \bar{c}]$. The incumbent A faces therefore the following maximisation problem for a given mark-up multiplier α_B^* in B 's strategy.

$$\max_{\alpha_A} E \left[(\alpha_A c_2 - c_2) \left(1 - \left(\frac{\alpha_A c_2}{\alpha_B^* \bar{c}} \right) \right) \right] \quad (10),$$

Using the first order condition for A 's maximisation problem we can define A 's optimal strategy.

$$p_{2A}^* = \alpha_A^* c_2 = \frac{1}{2} (c_2 + \alpha_B^* \bar{c}) \quad (11)$$

From equations (11) one can follow that A offers a higher price when B s mark-up multiplier a_B^* increases. In addition A offers a higher per-unit price when B s uncertainty about true costs increases. Such uncertainty increases when \bar{c} increases. Due to the trade off between mark-up and probability of winning the minimum offered price amounts to $1/2\alpha_B^*\bar{c}$. And we know $1/2\alpha_B^*\bar{c} \geq 1/2\bar{c} > 0$. In order to derive an explicit Nash equilibrium in the first stage of the game, we would have to consider B s optimal price strategy in equation (11). However, due to the assumed information asymmetry defining an explicit Nash equilibrium in the second stage of our model is not only expected to be complex, in addition it requires extended rationality from A . In order to ease our analysis we omit defining such equilibrium. Instead we analyse A 's investment behaviour given B s strategy a_B^* . Such procedure corresponds to a decision theoretic approach, where the case of only *one strategic bidder* is analysed (see Engelbrecht-Wiggans, p. 124)¹¹. Since our analysis is focused on A 's investment behaviour, it is appropriate to use such approach. Using a_B^* and A 's price strategy from (11) we can define A 's maximisation problem at the first stage of the game as follows:

$$\max_{I_1} p_{1A}q_1 - C_1(q_1 + L_1(I_1)) - K(I_1) + \delta \left[\frac{1}{2}\alpha_B^*\bar{c}q_2 - \frac{1}{2}C_2(q_2 + L_2(I_1)) \right] \left[\frac{1}{2} - \frac{C_2(q_2 + L_2(I_1))}{2\alpha_B^*\bar{c}q_2} \right] \quad (12)$$

Since we assumed B s strategy as given and since B can not observe or anticipate A 's investment behaviour in the first stage, the actual amount of investment is not expected to have an impact on B s mark-up strategy: $\partial\alpha_B^*/\partial I_1 = 0$. In addition we know that $a_B^* \geq 1$. Using the first order condition

¹¹ Other bidders are assumed to be non-strategic. In such setting the strategic bidder defines its optimal bidding strategy *given* the other's bidding behaviour. Such behaviour can be assumed to be random. In our model the strategic bidder has beliefs about the other bidder's cost forecasts c_{2B} . Therefore B s offered per-unit price $p_{2B} = a_{2B} c_{2B}$ is random from A 's point of view. Of course one could extend the model by introducing an additional distribution function $F(\cdot)$ from which A derives its estimation of B s mark-up multiplier a_{2B} . In order to ease the analysis we assume that A assesses a_{2B} at a_{2B}^* .

regarding I_1 allows us to derive the optimal level of investment into the pipe network in the first period.

$$\frac{\partial K(I_1)}{\partial I_1} = - \left[\left(\frac{\partial C_1}{\partial(\cdot)} \frac{\partial L_1}{\partial I_1} \right) + \left(\delta \frac{\partial C_{2A}}{\partial(\cdot)} \frac{\partial L_2}{\partial I_1} \right) \left(\frac{1}{2} - \frac{C_2(q_2 + L_2(I_1))}{2\alpha_B^* c q_2} \right) \right] \quad (13)$$

Obviously the first term of the right hand side of equation (13) denotes A 's direct investment incentives from period one. Higher investment reduces water leakage and therefore costs in the first period. Investment therefore increases profit in the first period directly. The second term is related to the second period. The marginal benefit of additional investment amounts to the marginal cost reduction multiplied with the probability of winning the auction. Such result is not surprising and follows from two effects. On the one side investment reduces treatment costs and increases the probability of winning the auction. On the other side the cost reduction directly increase profit in the second period. One can easily show that in our model both effects have the same size. Adding the effects leads to the second term in equation (13). Such result is intuitive: basically the marginal benefit of an investment amounts to the marginal cost reduction in the second period. However, the incumbent profits from such cost reduction only with a certain probability. Such probability is higher at higher levels of I_1 , since lower per-unit costs would cause a lower offered per-unit price in equilibrium.

From equation (13) we can follow that A 's investment incentives are increasing in α_B^* . A higher α_B^* increases A 's probability of winning the auction on the one side and allows A to increase the own offered per-unit price p_{2A} on the other side. Investment into the pipe network gets more attractive, since the hazard of the hold-up decreases. In addition investment increases when B 's uncertainty about the true costs increases. Again, the increased uncertainty increases the probability of winning the re-auction and allows A to bid a higher per-unit price. Additionally investment increases in the discount factor δ .

4.3.2 Second-price sealed bid auction

A regulator could alternatively use a second price sealed bid auction. Such rule was proposed by William Vickrey (1961). In practice such auction scheme is less common for concessions than first-price auctions. However, second-price auctions have been used as well. New Zealand, for example, applied second-price sealed bids to auction licenses for radio spectrum (see Klein 1998/a, p. 1). In a second-price sealed bid auction the bidder with the lowest per-unit price bid wins the auction. The actual price that the winner can charge to customers equals the second lowest bid. Again we solve our model by backwards induction. At the second stage of the game the participants of the auction define their per-unit price offers. Obviously we can define the player's strategies more easily than in the first price auction. In the second-price auction both bidders A and B have strong incentives to bid a per-unit price that equals the own average treatment costs in period two. Since the actual price is independent of the own bid, the bidder maximise expected profit only by maximising the probability of winning the auction. Obviously bidding average costs is a dominant strategy for both. Such result is not surprising and is very well known in auction theory (see Becker 2001, p. 8). In our model we assumed a common value auction, where winning the auction has the same value for both bidders. However, such assumption does not change their strategies, since the second-price sealed bid auction with only two bidders does not allow any bidder to gather any information about the other's cost forecast.

Since both players have a dominant strategy that is independent from the other's strategy we can easily define a Nash Equilibrium in the first stage of the game. A 's equilibrium strategy is defined as $p_{2A}^*(c_2) = c_2$, the entrant B 's strategy as $p_{2B}^*(c_2) = c_{2B}$. However, A can not observe c_{2B} . Instead A has a believe about it which is based on the uniform distribution $[0, \bar{c}]$.

Since A wins the auction when $p_{2A}^* < p_{2B}^*$ respectively when $c_2 < c_{2B}$ we can define A 's perceived probability of winning the auction as follows:

$$prob(winning) = \left(1 - \frac{C_2(q_2 + L_2(I_1))}{q_2 c} \right) \quad (14)$$

And the estimated price given A wins the auction can be written as follows:

$$E(p_2 | c_2 < c_{2B}) = \frac{1}{2} \left(c + \frac{C_2(q_2 + L_2(I_1))}{q_2} \right) \quad (15)$$

We can use (14) and (15) in A 's maximisation problem in the first stage of the game:

$$\max_{I_1} p_{1A} q_1 - C_1(q_1 + L_1(I_1)) - K(I_1) + \delta \left[\frac{1}{2} c q_2 - \frac{1}{2} C_2(q_2 + L_2(I_1)) \right] \left[1 - \frac{C_2(q_2 + L_2(I_1))}{q_2 c} \right] \quad (16)$$

Using the first order condition regarding I_1 allows us to derive the optimal level of investment into the pipe network in the first period.

$$\frac{\partial K(I_1)}{\partial I_1} = - \left[\left(\frac{\partial C_1}{\partial(\cdot)} \frac{\partial L_1}{\partial I_1} \right) + \left(\delta \frac{\partial C_2}{\partial(\cdot)} \frac{\partial L_2}{\partial I_1} \right) \left(1 - \frac{C_2(q_2 + L_2(I_1))}{q_2 c} \right) \right] \quad (17)$$

The result is not very surprising. Again, the first term of the right hand side of equation (17) denotes A 's direct investment incentives from period one. Investment increases profit in the first period directly. The second term is related to the second period. The marginal benefit of additional investment amounts to the marginal cost reduction multiplied with the probability of winning the auction. Such result exactly corresponds to the one in the first price sealed-bid auction in section 4.3.1. However, the relevant probability of

winning the auction is defined different since A 's bidding strategy in the two auction schemes varies.

4.3.3 English auction

In open auctions such as Dutch or English auctions bidders gather at one place. Such schemes allow bidders to observe others' bidding behaviour. Open auctions are less common for concessions than sealed bid auctions. Dutch auctions are often used for selling fast perishable goods such as flowers or food. English auctions are very common for selling unique goods such as art or antiques (see Becker 2001, p. 3). Traditional auction theory predicts similar bidding strategies in first-price sealed bid and Dutch auctions respectively second-price sealed bid and English auctions. However, such result requires independent private values: each bidder knows its valuation for a good exactly and knows that such value is statistically independent from others' valuations. Bidding strategies are expected to be different in models assuming statistical dependence among bidders' value estimates. Milgrom and Weber (1982) analysed bidding behaviour in a general auction model with independent private values and common values as polar cases. They show that in contrast to the model with independent private values the second-price sealed bid auction and the English auction are not equivalent. Instead the English auction leads to larger expected prices (respectively to lower expected per-unit retail prices in our auction scheme) than the second price auction. The English auction therefore influences the degree of competition positively, since bidders tend to bid more aggressively. However, they show that bidding strategies in the Dutch and the first-price sealed bid auction are still equivalent – just as they are in private value models (see Milgrom and Weber 1982, p. 1095).

Our model is based on statistical dependence among bidders' value estimates. We assume a polar case with only one common value for the concession. Such value is determined by true average costs c_B . Bidders have

different estimates about costs in the second period and therefore about the common value. Due to the assumed asymmetry the incumbent A has superior information about true costs: A 's cost estimate equals c_2 . B only has an estimate c_{2B} about it. Since B knows about A 's information advantage, one can follow that B 's estimate must be perfectly correlated with A 's cost forecast. In the following we focus the English auction scheme, since bidding strategies in Dutch and first-price sealed-bid auction are expected to be equivalent. Again we solve our model by backwards induction.

First, we analyse the player's bidding strategies in the auction stage. In the English auction scheme the auctioneer reduce the per-unit price p_2 incrementally. Bidders decide if they are still willing to participate in the auction at the actual price level or if they want to leave the auction. The auctioneer stops reducing the per-unit price when only one bidder remains. One can easily derive the bidders' strategies. The incumbent A is willing to participate in the auction as long as the auction price p_2 exceeds c_2 . At a level of $p_2 = c_2$ A is indifferent since profit would be zero in the second period. A therefore signals to leave the auction exactly when $p_2 = c_2$ since a lower per-unit price would cause a negative profit. One can follow that A has a dominant bidding strategy: participating in the auction as long as $p_2 > c_2$, leaving the auction at $p_2 = c_2$. Now we can define B 's strategy as a best response to A 's dominant strategy. The English auction scheme allows B to observe A 's bidding behaviour and therefore to gather information about true costs c_2 : as long as A decides to participate in the auction, p_2 exceeds c_2 . Obviously it would not be rational for B to leave the auction procedure before A , since treatment costs are the same for both utilities in the second period. The rational player B knows about A 's dominant strategy to leave the auction at $p_2 = c_2$. There is only one best response: waiting until A stops bidding and gathering the concession at $p_2 = c_2$ – since the auctioneer stops reducing the price when the other bidder signals to leave the auction. Considering both players' strategies we can derive the Nash equilibrium. The resulting price level amounts to $p_2 = c_2$, the expected profit from period

two amounts to zero. Additionally the entrant B can expect to win the auction definitely. One can easily define A 's maximisation problem at the first stage of the game, where it decides about optimal investment:

$$\max_{I_1} p_{1A}q_1 - C_1(q_1 + L_1(I_1)) - K(I_1) \quad (18)$$

Using the first order condition regarding I_1 allows us to derive the optimal level of investment into the pipe network in the first period.

$$\frac{\partial K_1}{\partial I_1} = - \left(\frac{\partial C_1(\cdot)}{\partial L_1} \frac{\partial L_1}{\partial I_1} \right) \quad (19)$$

Equation (19) exactly corresponds to equation (5). A 's investment incentives in the English auction equal the investment incentives of a one-period monopoly. Obviously there is no marginal benefit of the investment related to the second period. Every cost reduction caused by investment would only reduce the second period per-unit price to the same extension. The result basically corresponds to Milgrom's and Weber's findings. They show that players tend to bid more aggressively in the English auction than in a second-price sealed bid auction. As a result, competition at the re-auctioning stage is higher and the expected per-unit price tends to be lower. Since we assumed a polar case where B 's cost estimation is perfectly correlated with A 's cost forecast, the resulting per-unit price equals c_2 .

4.3.4 Evaluating the auction schemes

In sections 4.3.2 to 4.3.3 we applied different schemes for the re-auction of a water monopoly considering the information asymmetries in a piped water market. In this section we evaluate and compare these schemes regarding the incumbent's incentives to invest in the first period of our model. It is

obvious that the introduction of any auction scheme lowers A 's investment incentives compared to the benchmark case, where the incumbent runs the monopoly both periods with certainty. Increasing competition lowers A 's probability to win the auction and therefore increases the hold-up problem. However, an incumbent still has positive investment incentives which are related to the second period, since investment can influence the probability of winning the re-auction on the one side and the profit margin in the second period on the other side. In order to compare the above described auction schemes regarding the incumbent's investment incentives, we have to analyse the impact of investment on profit margin and probability of winning.

It is easy to show that based on our model the hold-up problem is the strongest in the English auction. From equation (18) we know that A can not expect a marginal benefit in the second period from investing in the first period, since the probability of winning the re-auction amounts to zero at any investment level. Comparing equation (19) with equations (13) and (17) one can easily show that equilibrium investment in the English auction is lower than in sealed bid auctions. However, the English auction assures the highest degree of competition, since the expected per-unit price equals true average treatment costs in the second period. The high degree of competition is a result of the open auction scheme which offers B to observe A 's bidding behaviour and therefore to anticipate true average treatment costs c_2 . Since A loses its information advantage, competition basically refers to a situation with two players facing similar costs. Such strong competition in the re-auctioning stage undermines investment incentives.

Sealed bid auctions in contrast offer the incumbent A to use its information advantage since B has no opportunity to observe or anticipate true average treatment costs. Obviously such information advantage lowers A 's perceived degree of competition at the re-auctioning stage and increases the probability to win. A can use such advantage by defining its bidding strategy in a way that maximises expected profit in the second period. Since

bidding strategies in the first- and the second-price sealed bid auction schemes vary, one can expect different investment incentives in these two auction schemes. Using equations (12) and (16), one can easily show that the impact of an additional amount of investment on the profit margin in period two is equal in both schemes. Higher investment causes lower treatment costs on the one side but a lower (expected) per-unit price on the other side. Potential differences in investment incentives are therefore caused by the impact on the probability of winning the re-auction. In fact we know from equations (13) and (17) that in equilibrium investment incentives in these two auction schemes vary with the probability of winning. In both schemes the marginal costs of investment equal the marginal cost reduction in the first period plus marginal cost reduction in the second period multiplied with the probability of winning the re-auction. Since the probability of winning the re-auction is defined different, the equilibrium investment may differ in the two schemes. In order to derive the equilibrium investment incentives in the first- and the second-price auction graphically, we define $\Omega(I_1)$ as the probability of winning in the first price auction, $\Phi(I_1)$ as the probability in the second price auction. Since demand is assumed to be constant we can use $q_2 = 1$ and therefore $C_2 = c_2$. $\Omega(I_1)$ and $\Phi(I_1)$ are defined as follows:

$$\Omega(I_1) = \left(\frac{1}{2} - \frac{C_2(q_2 + L_2(I_1))}{2\alpha_B^* \bar{c}} \right) \quad \text{and} \quad \Phi(I_1) = \left(1 - \frac{C_2(q_2 + L_2(I_1))}{\bar{c}} \right).$$

Both functions are increasing in \bar{c} and increasing in I_1 , since a higher I_1 lowers average costs c_2 in the second period. However, a higher I_1 raises the probability of winning in the second price auction stronger than in the first price auction, since the marginal effect of an additional investment tends to be stronger in the second price auction:

$$0 < \frac{\partial \Omega(I_1)}{\partial I_1} < \frac{\partial \Phi(I_1)}{\partial I_1}$$

Additionally we know that $\partial^2 \Omega(I_1)/\partial I_1^2 < 0$ and $\partial^2 \Phi(I_1)/\partial I_1^2 < 0$ since $\partial^2 C(I_1)/\partial I_1^2 > 0$. In the second price auction the probability of winning amounts to a maximum of 1 in case of very high investment respectively very low costs C_2 . In the first-price auction the probability of winning amounts to a maximum level of only 1/2. Such result is not surprising: since A faces a trade off between maximising the probability of winning and maximising the profit margin the offered per-unit price amounts to a minimum of $1/2\bar{c}$. However, one can not follow that the probability of winning is always higher in the second-price auction. At very low equilibrium levels of I_1 respectively at very high cost levels where c_2 converges to \bar{c} the value of $\Omega(I_1)$ may exceed $\Phi(I_1)$. Such case requires

$$c_2 > \frac{\alpha_B^* \bar{c}}{2\alpha_B^* - 1} \quad (20)$$

Obviously this condition is only fulfilled for a sufficient high level of α_B^* . In case of very intensive competition where $\alpha_B^* = 1$ the values of both $\Omega(I_1)$ and $\Phi(I_1)$ amount to zero at $I_1 = 0$ respectively at $c_2 = \bar{c}$; $\Phi(I_1)$ always exceeds $\Omega(I_1)$ at positive investment levels. In order to derive the equilibrium investment we have to consider the additional terms in equations (13) and (17).¹² We define:

$$\Psi(I_1) = \frac{\frac{\partial K(I_1)}{\partial I_1}}{-\delta \frac{\partial C_{2A}}{\partial(\cdot)} \frac{\partial L_2}{\partial I_1}} > 0$$

¹² Since investment incentives related to the first period are similar in both schemes, we can ignore them. Therefore we set the first terms of the equations (13) and (17) equal to zero.

where $\Psi(I_1)$ is positive since $-\partial C_{2A}/\partial I_1 > 0$ and $\partial K_1/\partial I_1 > 0$. Additionally $\partial\Psi(I_1)/\partial I_1 > 0$ since $-\partial^2 C(I_1)/\partial I_1^2 > 0$ and $\partial^2 K_1/\partial I_1^2 > 0$.¹³ Figure 3 shows $\Omega(I_1)$, $\Phi(I_1)$ and $\Psi''(I_1) > \Psi'(I_1)$.

In both auction schemes equilibrium investment tends to be higher at a lower levels of $\Psi(I_1)$, where $\Psi(I_1) = \Psi'(I_1)$. Lower levels of $\Psi(I_1)$ are caused by a lower value of $\partial K_1/\partial I_1$ or an increased value of $(-\partial C_2/\partial I_1)$. Obviously investment gets less expensive and therefore more attractive. From Figure 3 one can follow that investment in second-price auctions tends to be relatively higher at lower levels of $\Psi(I_1)$ where marginal costs of investment are low or the impact of additional investment on treatment costs is high. At very low levels of $\Psi(I_1)$ investment incentives in the second price auction scheme converge to the investment level in our benchmark case, where the incumbent runs the monopoly in both periods with certainty. Increasing marginal costs of investment weakens the second-price auction's relative performance. The first-price auction gets relatively more attractive. At a sufficient low level of $\Psi(I_1)$ equilibrium investment $I_{1\Omega}''$ in the first-price auction may even exceed investment $I_{1\Phi}''$ in the second price auction – provided $\Omega(I_1)$ exceeds $\Phi(I_1)$ at very low levels of I_1 . Since the resulting I_1 in equilibrium tends to be very low in *both* auction schemes, A expects high average costs in the second period. In this case the probability of winning the re-auction tends to be higher in the first-price auction: since A expects B charging a positive mark-up as well, A perceives a positive probability of winning the re-auction even when its investment is very low and costs in period two are high.¹⁴ As a result investment incentives are higher in the first-price auction, where the hazard of hold-up is lower.

¹³ The second deviation of $\Psi(I_1)$ can be assumed to be positive when assuming all third deviations as zero.

¹⁴ Obviously A can expect a (small) positive probability of winning the re-auction even when actual marginal cost in the second period are close to \bar{c} since B might offer a price that exceeds \bar{c} as well. However, in the second-price auction scheme the probability of winning amounts to zero when $c_2 = \bar{c}$.

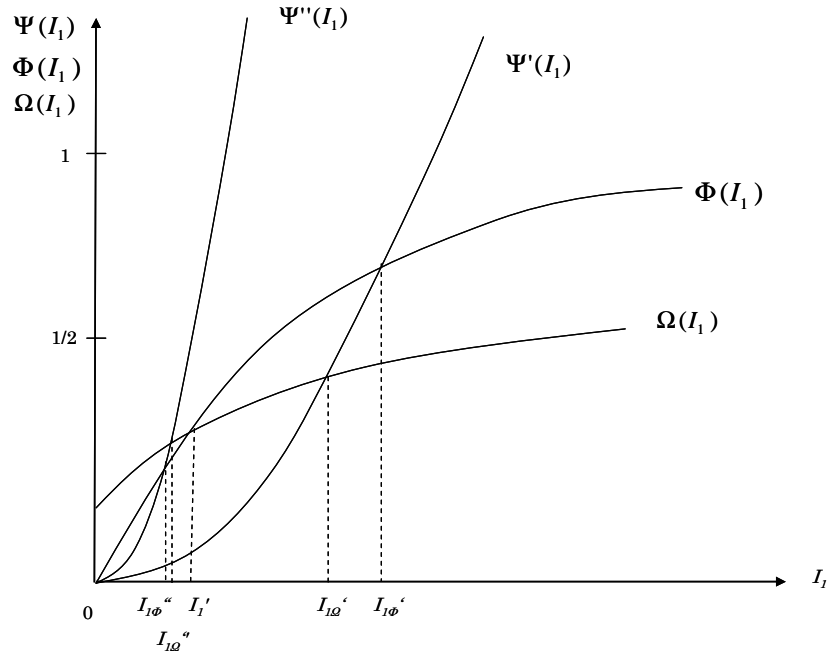


Figure 3 : Investment incentives in the first- and the second-price auction schemes

Additionally the relative performance of the first-price auction can be altered by varying the perceived degree of competition. Competition is basically determined by a_B^* – A 's assessment of B 's mark-up multiplier. A higher level of competition is associated with a lower level of a_B^* , since player B bids more aggressively. Obviously a lower value of a_B^* reduces the value of $\Omega(I_1)$, but increases the slope of $\Omega(I_1)$. In Figure 4 the mark-up multiplier a_B^* is lower in $\Omega''(I_1)$ than in $\Omega'(I_1)$.

At a given level of $\Psi(I_1)$ the equilibrium investment I_1 in a first-price sealed bid auction scheme is higher at lower levels of competition. Such result is not surprising, since the higher a_B^* increases A 's probability of winning the auction on the one side and allows to increase the own offered per-unit price p_{2A} on the other side. Investment into the pipe network gets more attractive, since the hazard of the hold-up decreases.

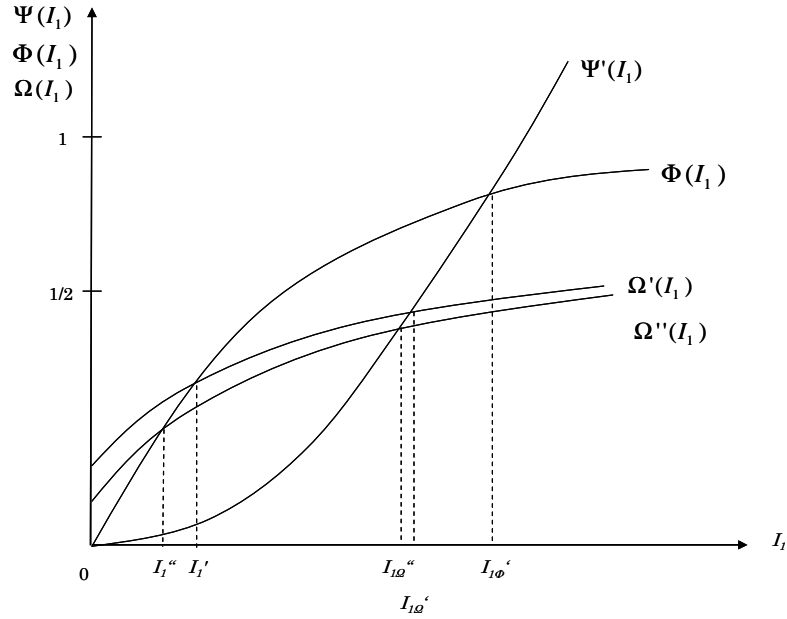


Figure 4 : Varying the degree of competition in the first-price sealed bid auction

From Figure 3 and Figure 4 we can follow that *both* auction schemes may be superior regarding investment incentives. One can summarise that investment in the second price auction tends to be relatively higher than in the first-price auction when marginal costs of investment are lower or the impact of investment on water losses is higher¹⁵. However, investment under the first-price auction scheme becomes relatively more attractive when investment into the pipe network is very costly and less efficient and competition is assumed to be weak. Therefore a regulator would need extensive information about costs and productivity of investment and therefore about the actual and future consistence of the pipe network and about the expected degree of competition in order to choose the sealed bid auction scheme that maximises the incumbent's investment incentives. However, it is assumable that the regulator's information about all these aspects is rather imperfect. The optimal decision is therefore expected to be

¹⁵ One can assume that costs and effectiveness of network investment vary with the consistency of the pipe network at the beginning of the two periods on the one side and the local circumstances on the other side. Such local circumstances depend on the character of underground material or on the situation at the surface. Obviously investment tends to be more expensive in urban than in rural areas, since construction works tend to be more complex and therefore costly.

very complex in practice. Additionally the regulator needs to be credible in order to achieve the desired investment behaviour of the incumbent utility. Obviously a regulator could have incentives for opportunistic behaviour. After announcing a sealed bid auction scheme at the beginning of period one he could rather use an English auction in order to maximise competition at the re-auctioning stage while keeping investment incentives. Of course the hazard of opportunistic behaviour increases the incumbent's hold-up problem and undermines its investment incentives.

4.4 Endogenous participation

So far the model assumed that each player A and B takes part with certainty in the auction procedure. We ignored their *incentives to participate* in the auction procedure and assumed the inexistence of any participation costs. In this section we extend the model by making the participation decision endogenous. Obviously any potential market entrant faces a significant risk due to lacking information about the network's consistence and therefore about actual future treatment costs. Making an obligatory per-unit price offer which does not cover average costs could end up in losses and finally in bankruptcy. As a result the participation in the re-auctioning procedure of a water monopoly concession tends not to be very attractive for any third party that has less information than the incumbent. To some extent this finding may explain the low degree of competition in the French water sector, where re-auctions are usually won by the incumbent or where re-auctions do not take place, since the concession is just re-awarded to the incumbent *without* any auctioning procedure.

Using the model outlined above it is easy to show that the potential market entrant B has the lowest incentives to take part in the re-auctioning procedure when choosing a second-price sealed bid scheme. Since we did not allow for firm specific efficiency differentials B only wins the auction when it is too optimistic about future treatment costs. If B wins the auction, it will

incur future losses. As a result B does not have any incentives to take part in the auction, since it can not be profitable. Now A is the only participant in the auction stage, competition does not take place. Such situation is equivalent with the benchmark case, where A runs the monopoly in both periods with certainty. The relevant investment incentives are outlined in equation (7). In case of the first-price sealed bid auction B 's problem concerning the 'winner's curse' tends to be lower than in the second-price sealed bid auction – B always faces a positive probability for positive profits. Considering B 's participation, A 's investment incentives are still the same as in the section above. B 's participation incentives are the strongest in the English auction, which allows gathering information about future treatment costs.

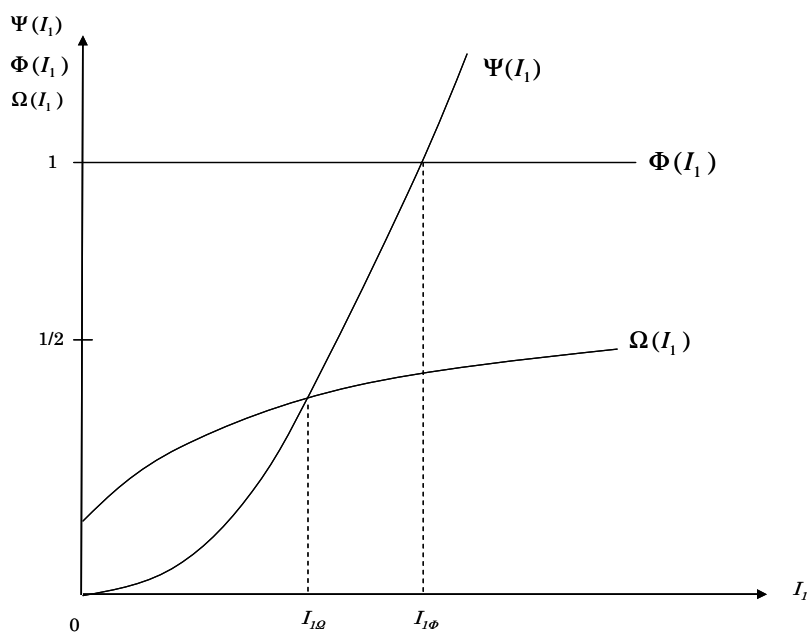


Figure 5 : Considering participation incentives

However, since A expects to lose the auction, A would not have any incentives to take part when assuming positive participation costs. Such behaviour shifts monopoly power to the entrant B , since there would not be

any competition at the auctioning stage. However, A 's investment incentives do not change compared to above. Again, we can illustrate investment incentives related to second period cost reductions graphically. Figure 5 compares the relevant investment incentives in a first- and a second-price sealed bid auction.

Considering endogenous participation we can easily show that A 's incentives to invest are the highest in the second price auction. A can expect the lowest degree of competition, since the auctioning scheme keeps potential market entrants from participating in the re-auctioning stage.

4.5 Firm specific efficiency differentials

Water utilities costs are mainly determined by factors such as quality of used raw waters, pipe network's consistence or production capacity. These parameters are not firm specific and can be seen as exogenously given for any market entrant B . Nevertheless there is some minor potential for firm specific efficiency differentials, mainly related to operational activities. Cost differentials between A and B are for instance caused by differences in organisational terms, employment contracts or technical skills. However, it is straightforward to show that allowing for efficiency differentials does not change the results from section 4.3 fundamentally.

The model can be extended by introducing a firm specific efficiency parameter θ_i into the cost function: $C_j = C_j(q_j + L_j(I_1), \theta_i)$, where j denotes the relevant period, $j \in \{1, 2\}$, i denotes the firm, $i \in \{A, B\}$ and $\partial C_j / \partial \theta_i > 0$. One can assume that each player knows his own θ_i but not the other's. The introduction of θ_i increases A 's uncertainty about B 's cost estimation – from A 's point of view the range of potential c_{2B} values increases depending on the assumed distribution of θ_B . We forbear to model this extension explicitly. However, we know that θ_B increases the values of c_{2B} at the upper end when A 's assumes that θ_B tends to be higher than θ_A . A fears less competition at

the re-auctioning stage, investment increases in the first- and the second-price sealed bid auction schemes. Additionally investment increases in both schemes at relatively lower levels of θ_A , since A 's perceived probability to win the re-auction increases. As a result, the introduction of θ_i may change the level of investment in both schemes, but it does not change their relative investment performance. But we gain additional information about B 's participation in the second-price sealed bid and the English auction: B does only participate when expecting $\theta_B \leq \theta_A$.

4.6 Vertical separation

Investment incentives may be different in a franchising model that assumes the vertical separation of operations from investment. In fact the Leasing contract is the most common used delegation contract in the French water industry (see Furrer 2004, p. 212)¹⁶. Under a Leasing contract (see Table 2) the franchisee is only responsible for operating the infrastructure including treatment of raw water and charging water fees to customers. Investment into the pipe and treatment facilities is excluded from the (re-) auctioning procedure. The municipal body or a strongly regulated infrastructure company owns the pipe and treatment facilities and is responsible for the entire investment. Financing the investment can be assured by charging utilization fees to the operating company that uses the infrastructure. In such Leasing approach only the *operation* of network and treatment facilities can be (re-) auctioned, the investment is excluded from the re-auctioning process. As a result the franchisee's hold-up problem is expected to be removed. However, vertical separation does not necessarily guarantee an optimal investment level. Obviously one has to consider investment incentives of the infrastructure company.

¹⁶ Full vertical separation has applied used as well in several other liberalisation processes, for example in the U.S. telecommunications industry or the British railway industry.

In this section we investigate investment incentives of a separated infrastructure company. For this reason we assume an independent upstream company U that owns the network infrastructure in both periods. Similar to the analysis above, we focus network investment and do not consider additional infrastructure such as treatment and storage facilities. One can assume U as a strongly regulated but profit-maximising private company.¹⁷ U 's revenues consist of utilization fees charged to a downstream company D which uses the network to render its water services. U charges a fee that depends on the amount of water transported through its network. Such fee is assumed to be linear and similar in both periods. In order to restrict U 's monopoly power a public regulator is required to restrict U 's freedom to determine the utilization fee by defining a price cap a_U . In our model a_U can be seen as exogenous. U 's costs are determined by investment costs $K(I)$ in period one. Since not relevant in our analysis we omit from further administrative costs. The upstream company's profit maximisation problem can therefore be defined as follows:

$$\max_{I_1} a_U q_1 - K(I_1) + \delta a_U q_2 \quad (21)$$

One can easily show that the infrastructure company U does not face any incentives to invest into the pipe network since additional investment only causes higher costs at constant revenues. Obviously U does not face any voluntary investment incentives since the resulting costs caused by water losses are not relevant in its income statement. As a result the regulator should not only regulate the utilization fee, in addition he is required to regulate and monitor U 's investment behaviour in order to ensure welfare maximisation. But as stated in Section 3.1 the regulation and monitoring of

¹⁷ Alternatively one can assume U as a publicly owned company. As stated in public choice theories public companies tend to follow other objects than maximising social welfare. One of these objects may be profit maximising. In fact some French municipal authorities used their water companies in order to improve their budget situation (see Furrer 2004, p. 214).

investment into underground pipes is expected to be difficult since it can not be observed and verified exactly by a third party.

However, a downstream company D that renders water services may complain that the upstream company U which fails to invest into the infrastructure is responsible for any water losses in its network. A regulator therefore may force U to compensate D for costs that arise from water losses. From Section 3.1 we know that these costs equal treatment costs for water losses. In order to calculate the compensation fee one has to measure water losses L_1 and L_2 in period one and two. In practice it is possible to measure the extension of water losses since they amount to the difference between sold water quantity and water quantity inserted into the pipe network. However, it requires metering of water consumption on the one side and metering of total production quantity on the other side. In order to determine the relevant compensation fee the regulator may multiply the fraction of water losses from total water production by the total of D s treatment costs. Obviously such computation tends to be feasible in practice, since water losses can be measured and total treatment costs can be extracted from D s income statement. Using the compensation fee in U s profit maximisation problem one can rewrite equation (21) as follows:

$$\max_{I_1} a_U q_1 - K(I_1) - \lambda_1(I_1) C_1\left(\frac{L_1(I_1)}{\lambda_1(I_1)}\right) + \delta \left(a_U q_2 - \lambda_2(I_1) C_2\left(\frac{L_2(I_1)}{\lambda_2(I_1)}\right) \right) \quad (22),$$

where

$$\lambda_1 = \frac{L_1(I_1)}{q_1 + L_1(I_1)} \quad \text{and} \quad \lambda_2 = \frac{L_2(I_1)}{q_2 + L_2(I_1)}$$

We can derive U s optimal investment level by using the first-order condition regarding investment:

$$\frac{\partial K_1}{\partial I_1} = - \left[\frac{\partial \lambda_1(I_1)}{\partial I_1} C_1 \left(\frac{L_1(I_1)}{\lambda_1(I_1)} \right) + \lambda_1(I_1) \frac{\partial C_1}{\partial(\cdot)} \frac{\partial L_1(I_1)}{\partial I_1} - \frac{\frac{\partial C_1}{\partial(\cdot)} \frac{\partial \lambda_1}{\partial I_1} L_1(I_1)}{\lambda_1(I_1)} \right] \quad (23)$$

$$- \delta \left[\frac{\partial \lambda_2(I_1)}{\partial I_1} C_2 \left(\frac{L_2(I_1)}{\lambda_2(I_1)} \right) + \lambda_2 \frac{\partial C_2}{\partial(\cdot)} \frac{\partial L_2(I_1)}{\partial I_1} - \frac{\frac{\partial C_2}{\partial(\cdot)} \frac{\partial \lambda_2}{\partial I_1} L_2(I_1)}{\lambda_2(I_1)} \right]$$

Obviously the introduction of a compensation fee in a model of vertical separation increases U 's investment incentives compared to the case without compensation fee since the right hand side of equation (23) is positive. Again we compare investment incentives given by equation (23) with investment incentives in the benchmark case given by equation (7). One can easily show that the right hand side of equation (7) is higher than the right hand side of (23) when

$$\frac{C_1(q_1 + L_1(I_1))}{q_1 + L_1(I_1)} + \frac{C_2(q_2 + L_2(I_1))}{q_2 + L_2(I_1)} < \frac{\partial C_1}{\partial(\cdot)} + \frac{\partial C_2}{\partial(\cdot)} \quad (24)$$

Assuming increasing marginal costs the right hand side of inequation (24) exceeds the left hand side. As a result investment incentives are always higher in the benchmark case where the vertically integrated utility runs the monopoly for two periods. The gap between actual investment in a model with vertical separation and the benchmark case is increasing in the second deviation of the cost function. At lower levels of $\partial C^2 / \partial(\cdot)^2$ the relative performance of the vertical separation with compensation fee is increasing. In case of linear treatment costs investment incentives are equal in both approaches. Such result is not surprising since in the model of vertical separation the compensation fee is computed based on average costs. U 's marginal cost savings arising from a lower compensation fee tend to be lower than marginal cost savings in an integrated water utility. However,

optimal investment can be implemented by adjusting the computation of the compensation fee. Obviously the fee would have to be based on the additional treatment costs that occur due to water losses. The compensation fee in period $i \in \{1, 2\}$ can be defined as follows: $C_i(q_i + L_i(I_1)) - C_i(q_i)$. One can rearrange U 's maximisation problem as follows:

$$\max_{I_1} a_U q_1 - K(I_1) - C_1(q_1 + L_1(I_1)) - C_1(q_1) + \delta(a_U q_2 - C_2(q_2 + L_2(I_1)) - C_2(q_2)) \quad (25)$$

However, such approach requires not only information about D 's total treatment costs. In addition the regulator needs exact know-how about the curvature of D 's cost function. In practice it is rather assumable that a regulator is not able to compute the “right” compensation fee, since D 's has private knowledge about its true cost function. Obviously D tries to overstate additional treatment costs due to water losses. As a result actual investment may exceed optimal investment. One can expect that such approach may be less applicable in practice, since the definition of “additional costs” tends to be problematic.

One can conclude that inducing a first-best solution in a vertical separated structure seems to be unrealistic. However, in practice one could implement a second-best solution where the relevant compensation fee is determined by multiplying the fraction of water losses from total water production by the total of D 's treatment costs. But our model did not count for potential economies of scope between rendering water services and carrying out network investment. In fact one can assume the existence of economies of scope. Both, operating and maintenance of network and treatment facilities require extended sanitary know how. Obviously increasing economies of scope worsen the relative performance of a model that assumes vertical separation.

5 Evaluating additional aspects

In section 4.3.4 we analysed the different auction schemes only regarding investment incentives. However, auction schemes can be evaluated from additional perspectives. According to Klein (1998/a, p. 1) the choice of an auction method for concessions is affected by three arguments: *i)* political sustainability of the outcome, *ii)* robustness of firms bidding strategies and *iii)* opportunities for collusion amongst firms. We follow Klein and evaluate auction schemes in the water industry according to these arguments. First we focus *i)*. Klein (1998/a, p. 2) claims that sealed bid second-price auctions are “clearly dangerous for political sustainability when there are only a few bidders”. Obviously the winner of a second-price auction may offer a per-unit price that is significantly lower than the second highest bid. However, the winner is allowed to charge a retail price that equals the second lowest bid. Of course welfare maximisation in a static model would require charging the lowest possible price.¹⁸ Milgrom (1989, p. 18) claims that a regulator faces incentives to manipulate the outcome of an auction procedure. Opening the bids allows the regulator to learn about the bidders valuations. What would prevent the regulator from inserting a false bid in order to lower the per-unit price? Milgrom adds that a second-bid auction in which the auctioneer inserts extra bids after opening the sealed-bids is virtually identical to a first-bid auction. Political sustainability tends to be higher when more bidders participate in the auction procedure since the probability of large and therefore unsustainable differences between their bids tends to be lower.¹⁹ Additionally sustainability tends to be higher in an open auction scheme such as the English auction. Since the auctioneer stops reducing the price when the second-lowest bidder leaves the auction, nobody knows about

¹⁸ The auction of a radio spectrum in New Zealand created political problems, since the first bid was NZ\$ 100,000, the second bid only NZ\$ 6. Obviously authorities had significant problems to explain such outcome to the public (see McMillan 1994).

¹⁹ However, experience from franchise bidding in the French water industry rather indicates that only a few bidders take part in the auction procedures.

the winner's potential lowest per-unit price. Klein follows that first-price and sealed bid auctions can both yield reasonable sustainability.

In addition the sustainability of the auction's outcome may differ in *ii)* the robustness of the bidder's strategies. Common value auction schemes complicate the player's strategy definition: the value of a concession not only depends on the bidder's personal valuation, in addition it depends on factors that affect all bidders. However, in a franchising procedure in the water sector one can assume that different bidders have different information – as assumed in the model above. Such setting holds a serious danger of the winner's curse (see Klein 1998/a, p. 3 or Wolfstetter 1994, p. 5). One can expect that the most optimistic bidder who assesses the relevant costs at the lowest level wins the auction – instead of the most efficient bidder. Obviously an overoptimistic bidder will suffer a loss during the following contract period. When the franchisee becomes aware of true costs, he tries to re-negotiate the contractual terms *ex-post*. Such behaviour undermines the benefit of competition at the re-auctioning stage. Anticipating the opportunity for re-negotiation allows bidders to bid more aggressively. However, the result of the auction is *not robust*, since one can expect that it will be changed *ex-post*. In fact re-negotiations in franchised water monopolies are fairly common. For example in the Buenos Aires water concession the winning company Aguas Argentinas was able to achieve 13.5 percent higher water tariffs than agreed in the original concession contract.²⁰ Klein (1998/a, p. 3) mentions that the hazard of the winner's curse and contract re-negotiations can be avoided by using an English auction. Such open auction scheme allows less informed bidders to gather information about true costs during the auction procedure. As a result the hazard of overoptimistic bidding tends to be lower. Such finding corresponds with the result of our model. Only the potential market entrant *B* can suffer a loss due to overoptimistic bidding, since the incumbent *A* has perfect

²⁰ In addition the minimum water connection fee was increased by 84 percent, the water infrastructure fee by 38 percent, the minimum sewerage connection fee by 42 percent and the sewerage infrastructure fee by 46 percent (see Alcázar et. al., 1999, p. 35).

information about costs in period two. Obviously the hazard of the winner's curse tends to be the highest in the first-price sealed bid auction. Since we assumed only two bidders in our model, there is no danger in the second-price sealed bid auction. But the problem would occur when assuming more than two bidders. Similar to Klein's findings the hazard of the winner's curse is the lowest in the English auction scheme, where the offered per-unit price never falls below true costs – independent of the number of bidders. However, there may be a trade off between minimising the danger of the winner's curse on the one side and maximising investment incentives on the other side.

A further argument concerns *iii*) the opportunities for collusion amongst bidding firms. The degree of competition at the (re-) auctioning stage tends to be lower at higher levels of collusion. As a result the per-unit price tends to be higher and social welfare lower. Bidding cartels are expected to be more stable in open auctions, since they allow firms to observe each other's bidding behaviour and they allow retaliation of other's defection immediately. However, Klein (1998/a, p. 3) argues that collusive behaviour may occur in sealed bid auctions as well if there is repeated bidding for concessions involving similar players. In fact collusion amongst bidders frequently happened in France, where the first-price sealed bid auction scheme predominates and where basically three main companies dominate the entire water market. In its critical report the French national audit court (Cour Des Comptes, 1997, p 125) stated the high degree of concentration resulted from "organised competition".

6 Summary and conclusions

Investment into underground water pipes tends to be very long-term oriented, specific and hardly to verify by a third party. Following Armstrong et al. (1994, p, 129) one should conclude that the capital intensive water industry is not really well suited for franchise bidding. Obviously short term

contracts undermine long-term investment incentives. The resulting hold-up problem causes a serious danger of underinvestment in franchised water monopolies. The model above which assumes that an incumbent firm can invest into long-term underground pipes in order to reduce water leakage and therefore (future) production costs strongly supports such conjecture. One can easily show that investment tends to be lower in a short term franchising contract. But one can not conclude that very long-term franchising contracts that exclude the opportunity of periodical re-auctions are superior in the water industry. Using a re-auctioning process is the only way to ensure competition. If a regulator decides to auction of a water monopoly, he has to consider periodical re-auction procedures. As a result he faces a trade off between introducing competition on the one side and keeping investment incentives on the other side.

However, the regulator should consider that the incumbent's investment incentives may be different when using different (re-) auction procedures. In fact the model above shows that investment incentives may vary in different auction schemes. One main result of the paper is that investment incentives tend to be the lowest in an English auction. Such open auction scheme allows potential market entrants to observe the incumbent's bidding behaviour and gather information about true production costs. Losing such information advantage weakens the incumbent's position in the re-auctioning process. The hold-up problem increases and undermines incentives to invest. Using a closed auction such as first- or second-price sealed bid auction allows the incumbent to benefit from its information advantage. Investing into underground pipes not only reduces future production costs, additionally it strengthens the incumbent's position in the re-auctioning process. Investment incentives in closed auctions tend to be higher than in an English auction. However, as shown in Section 4.3.4 investment incentives may be different in a first- and a second-price auction scheme. Depending on several conditions investment may be superior in one of these schemes. The model shows that investment in the second price

auction tends to be relatively higher than in the first-price auction when marginal costs of investment are lower or the impact of investment on water losses is higher.

When deciding about the applicable auction scheme the regulator may take additional aspects into account. As showed in Section 5 political sustainability of the auction outcome tends to be higher in a first-price sealed bid and in an English auction since the regulator can not identify the bidder's minimum average costs. In a second-price sealed bid auction, where the bidder's reveal their minimum costs, the regulator has incentives to manipulate the outcome ex-post in order to minimise the per-unit price. In addition the English auction tends to be most favourable when evaluating auction schemes regarding the hazard of the winner's curse. However, the English auction allows bidders to observe each other, which supports stability of potential bidding cartels.

In order to decide about the applicable auction scheme, the regulator needs to evaluate and to assess all the arguments above. If investment is a very important issue in its evaluation, he should use a sealed bid auction scheme. Based on additional information about the specific market the regulator then has to decide about a first- or a second-price auction scheme. However, such decision tends to be complex in practice, since one can assume that the regulator's information is rather imperfect.

The regulator can eliminate the incumbent's hold-up problem by implementing vertical separation. Investment into the pipe network is excluded from the franchise bidding procedure and is carried out by a separated infrastructure company. However, in order to optimise investment incentives the regulator has to implement a complex compensation system. The infrastructure company compensates the operator for costs arising from water losses. Again, information asymmetries complicate the computation of the relevant compensation fee. However, when evaluating vertical separation more detailed, one has to consider potential economies of scope between carrying out investment and operating the network.

Obviously one can not expect to implement a first-best solution when using a franchise bidding procedure in the piped water industry. Using any kind of auction design induces the hazard of underinvestment. One may ask the question, if franchise bidding is a valuable alternative in the piped water sector. However, in practice several municipal authorities, for example in France, used franchise bidding due to a lack of financial resources and technical know-how. Investment into the pipe network under a franchising regime may be suboptimal but still higher than under a public ownership.

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