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BACHELOR THESIS

An Evaluation of Water Supply Ownership in Europe

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Declaration of Authorship

I hereby declare that I wrote my bachelor thesis independently under the leadership of my supervisor and that the references include all the resources and literature I have used. I also proclaim that this thesis has not been used to obtain the same or any other degree.

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Souhlasím s tím, aby byla práce zpřístupněna pro studijní a výzkumné účely.

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Abstract

This thesis deals with the topic of effective ownership structures in the water supply industry in Europe. It gives background information on the types of ownership and the cooperation between public and private sector. Furthermore, it gives an overview of state regulation and the competetive nature of the water supply market and explains how the water is priced by the companies. The core of the thesis is the evaluation of performance and effectiveness of private and public entities in water supply. Past literature and research are discussed regarding the performance of each sector and the case of Italian water supply services is given leading to reasons for water privatization. This work further develops the effectiveness of public-private partnership with regards to water provision. Moreover the multiple regression analysis shows the dependence of water tariffs on privatization level, competition, the amount of the freshwater resources and volume of abstraction, and 'richness' of selected European regions. This gives a reasoning of water price setting and shows the influence of ownership on the level of the tariffs. This paper provides not only solid understanding of the effective water supply ownership issue, but also provides a base and suggestions for further research.

Keywords water supply, public-private partnership, water tariff, effectivity of water supply, privatization, water ownership, regulation, water industry

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Abstrakt

Tato práce se zabývá tématem efektivnosti vlastnických struktur ve vodárenství v Evropě. Poskytuje základní informace o typech vlastnictví a spolupráci mezi veřejným a soukromým sektorem. Dále je uveden přehled státní regulace a hospodářské soutěže ve vodárenství a vysvětlení toho, jak je cena vody sestavena. Jádrem práce je hodnocení výkonnosti a efektivnosti soukromých a veřejných subjektů v zásobování vodou. Předchozí literatura a vědecký výzkum o výkonnosti jednotlivých sektorů je diskutován spolu s případovou studií z Itálie. Poté jsou také nastíněny důvody pro privatizaci vody. Tato práce rozvíjí pomocí vícenásobné regresní analýzy závislost cenových tarifů na úrovni privatizace, konkurenci, množství sladkovodních zdrojů, velikosti abstrakce vody a příjmu obyvatel ve vybraných evropských regionech. Model odůvodňuje stanovení cen vody a ukazuje vliv vlastnictví na úroveň sazeb. Tato bakalářská práce poskytuje nejen solidní porozumění vlivu jednotlivých vlastnických struktur na efektivnost a cenu dodávek vody, ale také dává podněty pro další výzkum.

Klíčová slova vodovody, partnerství veřejného a soukromého sektoru, cena vody, efektivita dodávky vody, privátní sector, regulace, vodárenství

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Acronyms

BOT Build, Operate, Transfer

CZ Czech Republic

CZK Czech koruna

DEA Data Envelopment Analysis

EC European Commission

EP European Parliament

EU European Union

EUR Euro

GBP British Pound

GR Greece

NGO Non-Governmental Organization

OECD Organisation for Economic Co-operation and Development

PPP Public-Private Partnership

SME Small and Medium Enterprises

UK United Kingdom

USD United States dollar

WSS Water Supply Services

Bachelor Thesis Proposal

Water and its ownership has been publicly discussed topic nowadays. Especially the European Commission's (EC) proposal for a Directive on the award of concession contracts raised the interest in water ownership structures and affordability of water supply for households. Many countries go down the road of privatization and big companies such as Veolia or SUEZ are gaining significant share on the market. It is questionable whether privatization does not lead to lower quality of water and much higher tariffs. People even launched European Citizens' Initiative in order to ban the EC's proposal and keep water in public ownership. Water supply also differs from state to state in Europe so I would like to take a look at the structure in each of the countries and find out where the most effective structure takes place.

Is it more effective to have water supply in the private or public ownership? How does the ownership influence the efficiency of water provision and water tariff? And is privatization the right solution for improvement of the supply?

These are the crucial questions I would like to answer in the thesis. I would also like to summarize the water industry and the types of ownership that there exist. By these structures I would like to identify how effective each of them are and what could be improved. In the best scenario I would like to find out what is the most effective ownership structure in provision of water supply.

The sections should include description of the water market, reasons for privatization, effectiveness of individual ownership structures with some case studies for each of the countries in the EU where available. The core of the work should be an econometric model where panel data or cross-sectional data will be used in order to examine the changes in a tariffs explained by privatisations or municipalisations.

Preliminary Resources

[1] OECD. (2010a). GUIDELINES FOR PERFORMANCE-BASED CONTRACTS BETWEEN WATER UTILITIES AND MUNICIPALITIES. ENVIRONMENT POLICY COMMITTEE. Almaty: OECD

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1 Introduction

The topic of water supply ownership is indisputably interesting for many reasons, from effectivity of water provision through state regulations, to the actual price setting. The level of private sector participation and new approaches towards Public-Private Partnerships (PPP) are being discussed on both a national and pan-European level. Even though there is a significant amount of literature focused on water issues, different opinions about private sector participation still remain. Many research papers have been addressing the question as to whether ownership (public, mixed, or private) is a significant determinant of the efficiency of water supply utilities, or if there are other core determinants such as location and size of the utilities. However, not many recent papers focused on the complex topic of the effective ownership structures. Some papers state that private companies raise prices in order to maximize their profits and the monopolistic nature of the industry to their advantage. On the other hand others argue that private companies have financial resources and know-how for investments and innovation and the actual water provision is then more effective. For this and other reasons, it is useful to examine the ownership structures and the options of effective PPP cooperation.

The aim of this thesis is then to bring together the relevant literature in order to create a comprehensive summary of the ownership structures and its effectiveness with regards to water provision. More precisely, this work focuses on the drinking water supply for households and possibly work places and excludes industrial and agricultural supply. The objective of this paper is to show the increasing efficiency of private companies and moreover it suggests the effective way of cooperation between public and private sector whilst being efficiently regulated by the governments. Furthermore this thesis examines the dependence of water tariff on the volume of available freshwater resources, consumption, its ownership structure and ‘richness’ of selected European regions.

The paper is structured as follows. First, the essential background is given, from the typology of ownership structures and the private sector participation, to the competition and regulation of the water supply market and the actual pricing of water. With chapter 5 starts the evaluation of performance of public and private utilities. In this section the studied literature is studied in detail, particularly focusing on the Italian scheme. Moreover, the reasons for water privatization and the vision for effective water supply is described. The last chapter includes the econometric model where water tariff is regressed in different specifications focusing particularly on the influence of private sector participation on the price of water. Then, conclusion follows.

2 Ownership in the Water Industry

When studying the public and private sector participation in the water industry, one has to first understand the heterogeneity of an international or local situation and the dynamic characteristic of choice between public and private water supply. Firstly, there is a noticebale difference in the urban and rural provision of water, whilst in rural areas, the local municipalities usually take on the responsibility to ensure access to clean water for all citizens. On the other hand in the urban areas, there exists space for competition and therefore municipalities often delegate supply to singular or multiple private companies. Moreover, ownership does not have static characteristics and changes over time depending on the need of investments, know-how, or effectivity in the water supply itself. History of water supply provision reflects the dynamic feature of choice between public and private ownership that lead to multiple "privatisations" and "deprivatisations".[1] In this chapter the possible ownership structures, the reasoning behind the choices and the roles undertaken by public and private sector will be illustrated.

2.1 Typology of Ownership Structures

The water supply sector is fragmented and diverse in the forms of private sector participation. Its players include state and local governments, municipalities, private sector companies whose primary interest is not water supply, but for instance water waste; small local companies, international, large-scale companies and in particular joint ventures between public and private enterprises. The most common approach nowadays is public-private partnership (PPP). In PPP, the private sector contributes with improved, specialist know-how and technology, with the public sector sharing the risk, providing funding and regulating possible inconsistencies.

[1] In England private water companies have been serving London for more than 200 years, until they were nationalized in 1903 and regrouped under a single public body, the Metropolitan Water Board. England "switched" back to private delivery and privatized water companies in 1989 (Pérard, 2009).

Due to the sector characteristics, need for investments and gradual improvements of infrastructure together with range of consumption, water services require public provision, or at least supervision. According to the EUREAU survey of EU Water Infrastructures from 1997, more than 60% of the EU water industry was managed under some form of direct public operational control. A summary of ownership structures and detailed description follows (see Table 2.1).

Table 2.1: Typology of Ownership Structures in the Water Supply Industry

	Government Department & Public Enterprise	Service Contract	Management Contract	Lease	Concession	Built, Operate, Transfer (BOT)	Joint Venture*	Divestiture**
Asset ownership	G	G	G	G	G	G	G/P	P
Investment	G	G	G	G	P	P	G/P	P
Financing Fixed assets	G	G	G	G	P	P	G/P	P
Commercial risk	G	G	G	Shared	P	P	G/P	P
Operation/ Maintenance* **	G	G/P	P	P	P	P	G/P	P
Source of Remuneration Of operator	Municipality	Municipality	Municipality: Fixed fee or based on performance	User fee + from municipality	Users	Municipality	Users	Users
Contract duration	No limit	1-2 yrs.	3-5 yrs.	8-15 yrs.	25-30 yrs.	20-30 yrs.	No limit	No limit

G=Government sector, P=private sector
* Netherlands, French Water Supply
** England
***Maintenance may lead to considerable amounts of investments on the side of the responsible owner.
Source: (OECD, 2009), (Boscheck, 2002)

Government ownership It may refer to public ownership or control of assets in the water industry in a set country or region. Moreover, it also includes state control of an enterprise at any level, whether it be national, regional or local (municipal). This transformation is called nationalisation or municipalisation and is an exact opposite from privatisation (see Box 2.1: The Case of Finland). In such a case, the government bears full risk and is the main investor to infrastructure. Governments often turn to the private companies for technological expertise and specialisation.

Box 2.1: The Case of Finland

In Finland, municipalities are responsible for water supply and sanitation inside population centres. They have the option of outsourcing the operation and maintenance of water supply to private companies, which is only the case of cooperative initiatives in rural areas. Usually municipalities establish their own water utility for the task. Such utilities take care of investements, operation and maintenance and invoice the cost of water fees. National supervision and the legislative control lie in the hands of Ministry of Environment, Ministry of Agriculture and Forestry and Ministry of Social Affairs and Health. Yet, crucial role is held by the EU Water Directives. The operation and management in urban areas of Finland is handled by municipalities, whereas in rural areas it is handled by cooperatives and households' individual resources.

(Finnish Water Forum, 2012)

Service contract In this aforementioned subcontracting arrangement, the private sector performs the administrative and technological tasks delegated by the public sector. These tasks include: maintaining assets; planning studies; construction; installing metering; collecting payments from the users; operating the water supply on daily basis. In this situation, a private company receives revenue as a fixed fee and bears minimal commercial risk. Such agreements last only for 1-2 years and are implemented even when the regulatory framework is weak.

Lease A leasing contract is an agreement, which leads to the private sector using public property. It has legal responsibility for operating the water service at its own risk, including maintenance of the infrastructure. However, major investments into assets or infrastructure expansion are still the responsibility of the public owner. The leaseholder pays fixed rent, but receives part of the water tariff revenues. The average length of lease contract is 12 years (For example of lease in Paris see Box 2.2).

Management contract Under this PPP type of contract the public entity delegates management and operational responsibilities to a private sector body in order to facilitate the transfer of know-how and move the industry towards further

privatisation. Legally, the users are still customers of the government. The remuneration of the private party is set on a fixed fee, depending on either the number of connections, volume of water sold, or even performance, in which case the private sector bears some commercial risk.

Box 2.2: SUEZ Environment Lease in Paris

From 1985 to 2009 in more than half of Paris, Lyonnaise des Eaux, a SUEZ ENVIRONNEMENT subsidiary, had a 25-year leasing contract for the distribution of drinking water and non- drinking water. In December 2009 the City of Paris decided to delegate water services back to the municipality ownership. Even though SUEZ claims to increase network efficiency from 78% in 1985 to 97% in 2009 and restore 3/5 of the drinking water infrastructure (SUEZ environnement, 2012), according to the City of Paris, the government was not able to properly regulate the company's financial practices, which lead to an escalation of the price of water. Due to the profit-oriented approach by the private operators, together with lack of regulatory measures from the public entities, the transfer of water distribution activities to Eau de Paris was one of the possible ways towards more transparent and effective water provision. Although one can opine why, after all the SUEZ' investments into the infrastructure (€ 122.9 million in 34 years), would the municipalities not prolong the lease as expecting higher revenues income.

BOT contract The private sector is in charge of designing, building and financing a new investment project. It also has to operate and maintain it for the concession period and then hand it over to the public sector. This mechanism has the advantage of not increasing the sovereign debt (OECD, 2010a). BOT contracts account for the high level of investment costs as well as the commercial and currency risk for the private operator.

Joint Venture This represents an ownership structure where municipality and private operator co-own the water supply industry in a region. The two shareholders share responsibilities and revenues. Usually, the largest part of shares is in the private holding, however governments own veto shares - nominal shares that overpower

other shares under certain circumstances. Therefore, governments keep their regulatory powers and can oversee possible further privatisation.

Joint ventures allow for an effective trade-off between know-how, investments, regulation and transparency. Its only disadvantage is the politically sensitive stability. Water co-operatives are usual in rural areas where the water delivery is rather local. A typical example of joint venture contracts can be seen in the Netherlands, where the Dutch Water Supply Act forbid privatisation in water service delivery and hereby remove the municipal companies' threat to be fully privatised. Joint ventures are also common in French Water Supply.

Divestiture Full divestiture is the when all assets are sold to a fully private company. The owner is responsible for operation, management and investment. They gain all revenue (including especially user fees), but also bear all risks. Although a monopoly, this is still overseen and regulated by NGOs.[2] This kind of ownership is not common across Europe, except England, described in Box 2.3.

Box 2.3: Water Supply Privatization in England

The English water sector was liberalised in 1989 due to the disastrous state of the infrastructure, which at that time had 29 water supply companies as well as ten public integrated water supply and sewerage utilities. All of the companies were privatised, and their number was reduced in the following years to ten integrated companies providing water for about 75% of the population and 12 water supply utilities providing water for the remaining 25% of the population in England and Wales. In order to ensure that privatised companies would not misuse their monopoly power, the water utility regulator Ofwat (the Water Services Regulation Authority) was established. Since Ofwat is not subject to directions from the UK's Department for Environment, Food and Rural Affairs and is entirely financed by fees from the water supply and sewerage utilities, its independence is ensured.

(Oelmann M. & Czichy Ch., 2013)

[2] NGO=Non-Governmental Organization, in the case of water supply one of the NGO sis for instance RegNet controlling for quality of privately owned water in the EU

2.2 Level of Private Sector Participation

Due to the essentiality of water, and being it a basic human right, water services are typically seen as publicly provided or closely regulated. In Europe, nearly 98% of households are connected to public water supply, which is above average in the world. Yet, further investments and improvements need to be implemented to increase efficiency, which is what the private companies bring to the water sector.

Since the 1990s, European water utilities have invested in excess of around €40 billion per year to increase efficiency of water infrastructures. Privatisation is attractive, offering financial resources and possible market competition-driven efficiencies and pricing policies. Many partial privatisations bring wide international cooperation, for instance in Hungary 40% of water is distributed by private companies/joint ventures and approximately 20% of all water companies are fully privatised. Some companies are Hungarian, but the well-known multinational companies, such as Veolia, SUEZ, RWE, E-on, and Berlinwaters, play crucial roles. This kind of competition has led to increasing productivity and consequent stable pricing (UNRISD, 2006).

Overall in OECD countries, the number of people relying on the private sector for water services ranges between 200 and 300 million, representing around seventeen to twenty-five per cent of OECD members' population (Pérard, 2009), although this figure is higher for Europe only. Predominant private sector participation (around seventy per cent) is present in the Czech Republic, France and Portugal. Yet, European countries differ from state to state and include all levels of private participation (see Figure 2.1).

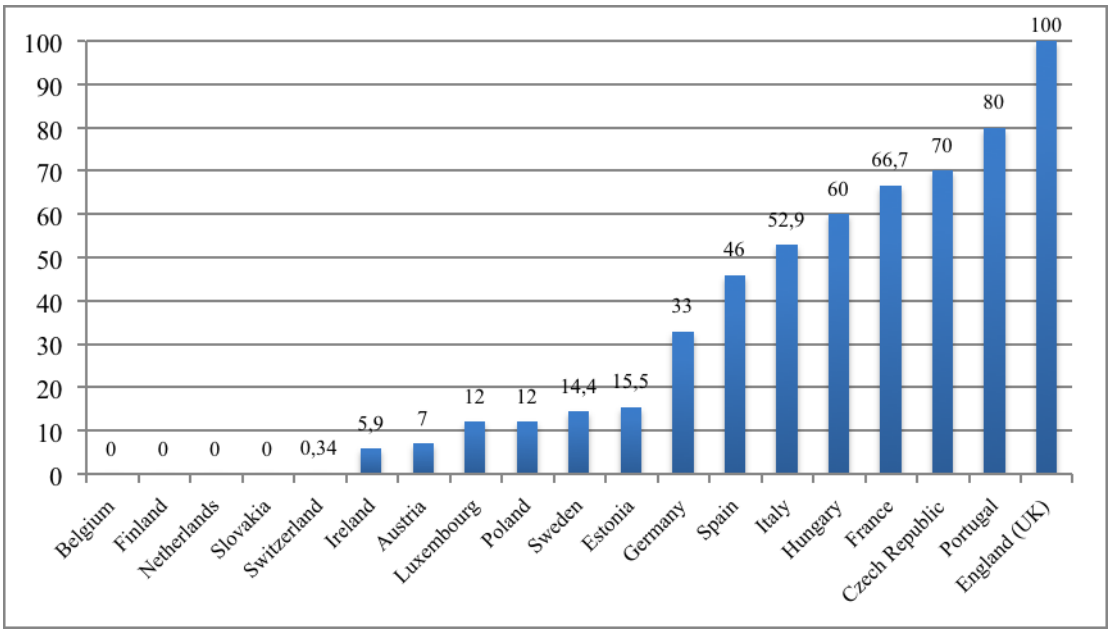

Figure 2.1: Private sector participation (%) in selected European countries

Source: Author's computations based on publicly available information for each country/region

The specificities of the water and sanitation sector may help explain the difficulties of as well as the constraints on private participation: *i)* the sector involves high fixed costs coupled with long-term irreversible investments; *ii)* water is a basic need with important externalities on health, gender equality and environment, which justify government intervention; *iii)* water and sanitation are managed at the local level, exposing the private sector to sub-sovereign risk; *iv)* the organisation of the sector is complex, due both to the number of stakeholders and to the segmentation of responsibilities across government tiers and agencies; *v)* the necessary long-term relationship exposes the partners to a number of contractual, regulatory and foreign-exchange risks (OECD, 2009).

2.3 Public-Private Partnership (PPP)

This kind of partnership is created to take advantage of the resources and capabilities of the private sector in the provision of public infrastructure or public services. Individual variants of PPP, if professionally and successfully applied, increase the quality and efficiency of public services, for instance public administration, and accelerate the implementation of major infrastructure projects with a positive impact on economic development. There are generally 3 different types of the PPP: management, lease and concession, with the concessions accounting for way over half of the partnerships signed.

Water privatisation, as a step of public procurement, has been a frequent measure in Europe for over 100 years, serving as a simple tool to increase capital for the public sector and improve the services for the consumer. By giving off some responsibility, public agencies were able to successfully improve the standard of living. Nowadays, many, not to say most services (such as waste disposal, water treatment & sewage, communication, etc) are handled by private operators and regulated in public-private partnerships.

PPPs are not universal and can take many forms, thus with no pan-European framework regulating their handling, corruption and other infringements can easily occur. PPPs have often been considered as a way to make the input and output more efficient and to increase the legitimacy of water governance. Concessions are often a policy alternative to privatisation, where competition on the market is not feasible or unlikely to flourish due to the presence of a natural monopoly or other structural conditions (Clifton J.C.&Díaz-Fuentes D., 2013). At the Johannesburg Summit 2002 the implementation of PPPs was heavily discussed, in particular the drinking water supply industry.

The partnerships can be seen as either challenges or opportunities for legitimate water governance (Dellas, 2011). Private sector participation, for example, may lead to efficiency gains, but is also often portrayed as lacking output legitimacy for potentially excluding those that cannot afford to pay for the service provided and ignoring less profitable regions (Swyngedouw, 2005). Several historical experiences have proven that revenue-oriented private water services can lead to lowering of

accessibility and affordability in rural areas, or to rising prices and lowering of the quality of drinking water, even in urban areas.[3]

On the other hand, water management being in public hands often leads to corruption, inefficiency, lack of transparency and innovation and, most of all, a lack of investment in sanitation and infrastructure.

Taking this into consideration, PPPs are considered to be the most effective type of ownership, if properly executed and maintained. The split responsibilities and tasks between private and public sector should bring more effectiveness and efficiency in the sector. Private involvement is known for contributing with specialised knowledge, research and innovation, as well as improvements in management, increased infrastructure investments and incentives for water conservation. Moreover, private companies tend to be more efficient in the water market when monitoring their operational costs, commercial aspects whilst still aiming for revenues. On the contrary, private companies often fail to improve water access, address local concerns or meet the price ceiling for all economic demographs. This is why the public partner has to be present. Governments or local municipalities provide the regulations concerning water accessibility for all in their region, water tariffs and drinking water quality.

Ultimately, the responsibility of drinking water provision lies in the hand of local public entities. Recently, the European Commission (EC) proposed a *Directive on the award of concession contracts* aiming to close regulatory loopholes that allow concessions to be awarded based on favouritism and unfair competition (see subchapter 3.2: Regulation).

[3] Berlin, capital city of Germany, privatised its water supplies in 1999 for roughly € 1.5 billion, leading to rapid increase of water prices with constant deterioration of water quality. In a long and expensive lawsuit, the city is slowly buying back shares of a British water provider.

3 Competition and Regulation on the Water Supply Market

The water industry is a specific field that differs from other industries in the forms of its operation. With its especially high fixed initial costs and need for investment the competition is rather impossible. Nonetheless, government regulations can either make the competition artificially possible, or lower the natural monopoly power of a provider. Water matters have also recently been discussed by the public recalling the EC's *Proposal for a Directive of the European Parliament (EP) and the Council on the award of concession contracts*.

More than 1.8 million EU citizens signed the European Citizens' Initiative calling for "refraining from turning water services into commercial services by excluding water from internal market rules. EC should commit not to liberalize water and sanitation services, not to include water and sanitation services in Trade Agreements such, to promote PPPs and to enshrine the 'water is not a commodity' principle of the Water Framework Directive in all EU water and water-related policies." (Citizens' Committee, 2012)

3.1 Competition

Direct and potentially perfect competition is the drive of efficiency and cost reduction on the market. Although for such a structure, the basic assumption is free entry to the market and an economically efficient market environment where a high number of competitors can negotiate.

On the contrary, the water market is limited by its significant sunk costs and the important role played by the concept of economies of scale. The scale of initial sunk investments results in a natural monopoly within the water market. Natural monopoly arises when the most dominant firm, the incumbent, on the market has a tremendous cost advantage over its actual and potential competitors. It is a monopolistic industry, most efficient when operated by a single firm where the competitive entry would be socially inefficient, as well as forced competitive behaviour. The conventional

wisdom is that these monopolistic utilities operate under decreasing average costs and increasing returns to scale. To put into context, the water sector has one set of pipelines that is operated by only one supplier.

Additionally, competition can be undermined by the limited number of bidders, for instance, according to the World Bank Policy Researches, the average number of firms participating in auctions is estimated around only 3.6 in the water and sanitation sector. Regulatory options dealing with these situations vary from local to pan-European regulations. They can focus on water tendering, price caps, maximum responsibilities or even forbidding private participation on the water market, such as in Netherlands. Contrary to that, competition among private actors in England is enforced by the government.

One way of possible competition creation could be the division of sanitation, transportation and metering of water. The competition in water production and treatment is more or less achievable as well as the final retail to consumers. On the other hand, water transportation via a network can be operated by one company only. Further regulations would be desirable, due to the contract among these three parts of water provision.

3.2 Regulation

Regulation is the decisions and instruments implemented within the framework of public actions, directly or indirectly, to improve social welfare. It includes laws and directives but also administrative formalities and code of conduct.

Regulation is a key issue in monopolistic sectors, where competitive pressures are limited, contracts incomplete, partnerships are multi-stakeholder and the relationships are long-term and thereby need to adapt to changes (OECD, 2009). Governments can take steps in order to strengthen the competition, increase affordability and accessibility of water services for all. They can limit restrictions on entry during the renegotiations and ensure fair settings for competition of all sizes, whether companies are national or international.

Regulations differ from ownership allocation to budgetary and ministerial control. Moreover, appropriate regulation is especially necessary in the water sector, taking into consideration the environmental issues and preserving the well-being of consumers. In general, there is a lack of capacity to control proper competition and monitor privatisation of the water supply. Since privatisations happen on municipal levels, and there does not exist a central authority to control these procedures. National authorities (for example the National Water Authority in Hungary) deal with water quality, as well as technical and environmental issues.

3.2.1 Types and concepts of regulation

In theory, regulation should keep in mind two crucial costs: firsly, the regulation enforcement cost including analysis, information and execution; secondly, the opportunity cost including the cost of wrong decision.

There are four main regulatory models: 1) regulation by government, 2) independent regulation, where independence has three dimensions: independence of decision-making, of management and of financing (usually referred to as the Anglo-American model), 3) regulation by contract, which specifies the regulatory regimes in legal instruments (usually referred to as the French model), and 4) outsourcing regulatory

functions to third parties, which makes use of external contractors to perform activities such as tariff reviews, benchmarking, dispute resolution (OECD, 2009).

Most models are not exclusively one or the another, but are generally a combination of above mentioned. From other point of view, concepts of regulation can be divided into: 1) regulating prices, both price-cap regulation and rate of return regulation, 2) regulating monopolistic market and protecting consumers, 3) measuring minimal water quality, and 4) environmental regulations. Regulation is also implemented at various horizontal levels, from local rules to national laws and European Directives.

Price regulation is mainly guided by trade-offs among the five following basic goals: 1) rent extraction or setting rates that strike a socially acceptable compromise between the interests of investors and consumers; 2) supply-side efficiency, or alternatively providing signals and incentives for suppliers and investors to increase efficiency, 3) demand-side efficiency or providing signals and incentives for efficient consumption of regulated utility services,4) revenue adequacy or allowing regulated firms to earn sufficient revenue to attract needed capital, 5) price fairness, or ensuring that prices are reasonable and contribute to universal service goals without creating significant distortions (OECD, 2009).

The possible measures taken are the price-cap regulation, the rate-of-return performance based regulation, and subsidisation.[4] For the case of price-cap regulation, the public authority sets a maximum tariff on water and sanitation services paid by the household or enterprise. Future unexpected costs that are not in control of private owner are taken into consideration, as well as future investments and improvements that are in hands of the concessionaire. The maximum price is therefore flexible and accounts for adjustments.

In the case of the rate-of-return price regulation, the regulator assigns value to the fundamental assets for services operations, with maintenance and rate of return being predicted in order to safeguard concessionaire's revenues. This process seems to be

[4] In Hungary, household prices are lower than industrial prices due to the heavy cross-subsidization. (UNRISD, 2006)

more efficient, as investors tend to spend more on the infrastructure and technology since all their costs are fully covered by the public body.

In reality, none of these types of regulations appear in the purest form; the most efficient regulations are hybrids of the aforementioned, in order to balance affordable tariffs, high water quality with interest and revenues of private actors.

3.2.2 The Commission's proposal for a Directive on the award of concession contracts

According to the EU, water supply is classified as a service of general economic interest (European Community Treaty, Article 86-2). The water supply services (WSS) must be provided to every citizen on a regular basis. The EC already issued a Water Framework Directive before addressing challenges faced by water resource management, introducing cost recovery for water services and polluter-pays principles.

The European Commission has recently proposed a new policy intending to increase the transparency and legal framework when giving out concessions. "*The Directive on the Award of Concession contracts"*[5] seeks to close loopholes when giving out enterprises. Strongly complying with the aims of the EU 2020 strategy,[6] the directive leaves no stone standing; even former taboos, such as privatisation of water, are 'approved' means of generating income - they are not specifically mentioned in the proposal, but the use of water concessions is indirectly suggested.

The European Commission has been aiming to change the regulations on water, energy and other public services delivery. Unlike the public procurement that has been subject to pan-European secondary regulation, the rules for designing,

[5] For the full text of the Commission's Proposal from 20.12.2011, press releases and brief summary, see: http://ec.europa.eu/internal_market/publicprocurement/partnerships/concessions/index_en.htm

[6] The *"EU 2020"* is a cohesive European Commission 10 year strategy aiming to achieve a new sustainable and greener economy by year 2020. The strategy focuses on targets such as employment, research and development, climate/energy, education, social inclusion and poverty reduction.

advertising and awarding PPP projects differ across EU governments. PPPs have become an important mechanism for financing and delivering water services. Their concessions account more than 50% of all PPPs, yet sets of unitary legal guidelines on the execution of concessions across the EU is missing. There is no set of secondary legislation concerning construction of water infrastructure, operation and delivery of the services.

The proposal was adopted by the EC on December 20th 2011. The main elements of the Directive include 1) a clearer and precise definition of concession, 2) the closure of loopholes in awarding concessions by establishment of selection and award criteria published in advance to ensure fairness, efficiency and proper market access also for small and medium businesses (SMEs) and 3) establishment of general guarantees for accountability of public authorities, transparency and legal certainty rather than mandatory procedures.

The EC denied that the purpose of the Directive was endorsement of privatisation of water utilities, instead the EC assured that this draft Directive does not require member states to privatise water, nor does it mandate that municipalities contract out services or works through concessions. This is not a liberalisation directive as introduced in the telecommunications and electricity sectors, for instance. It forces municipalities or governments to open their bidding process, should they decide to launch one, to any other entity in the EU which seeks to apply (Clifton J.C. & Díaz-Fuentes D., 2013).

4 Pricing Water

Anything scarce and in demand commands a price. This is one of the basic principles of economics. Effective and efficient water pricing systems provide incentives for efficient water use and for water quality protection (Jones, 2003). Water is priced for the reason of sustaining the accessibility to the clean drinking water for all through infrastructure development and expansion. Water prices differ among the European states. One reason for that is the worsening state of infrastructure and the high need for innovation in some countries. Moreover, some European states face the scarcity of freshwater and higher charges are levied on the water abstraction.

The government budgets being quiet limited causes even more variety. Governments have the option of increasing taxes on water or putting a stop sign on funds provision in order to put the money in different fields of struggling economy. While structures for municipal and household water supply remain reflecting the full costs of water provision, government still heavily subsidises irrigation and other agricultural water use. This often leads to inefficient use of water resources and to water stress in individual countries.

Water tariff, price of water, water rate and water charge, all these labels that can be linked with the assigned price to drinking water supplied to the customers from public or private utility through water infrastructure. These labels are often also applied to wastewater tariffs or agricultural supply. In this chapter the focus is explicitly on drinking water supply. Water tariffs are different from the actual price of water that also includes abstraction costs and various charges levied on environmental policies and fees on water extraction itself. The mechanisms of tariff settings differ from country to country. The reasonable criterion is the cost coverage. The bases for setting water prices are formal and informal criteria. Formal criteria are usually financial, economic and environmental. Water charges should cover the cost of abstraction, wastewater treatment (also referred as water recovery), renovations of the infrastructure, sanitation and costs of preserving the environment (water conservation). The differentiation of tariff structures among countries reflects high

decentralisation of water management as well as the geographical position of the region. The provision of water in rural areas is often more costly than provision in urban areas. The reasoning is simple, in rural areas the density of people connected to the water infrastructure is significantly smaller than the density in metropolitan areas, which increases the average cost of water supply per household.

Setting the water price consists of adding together smaller parts of the tariff. It usually consists of fixed part and variable part. Fixed charges often reflect the water stress and infrastructure development in the region. The use of fixed charges alongside with volumetric components is popular in the OECD countries. Obviously, volumetric tariff can be applied only there where water metering is settled.

There exist two contradictory types of volumetric charges. The first increases with the volume of water consumption, called increasing-block tariffs (IBT). This approach is justified by the environmental reasons and scarce nature of water supply. It is especially applicable for the water use in industry field, but also in order to lower water consumption in households. The second is the decreasing-block tariffs (DBT), where the volumetric charges decrease with consumption. The DBT is applied on the basis of the decreasing marginal costs. The systems of pricing water vary from state to state also because of different taxes levied on water supply. The taxes are both corporate taxes levied on the operators, as well as value added tax paid by the end consumers.

5 The Evaluation of Performance of Public and Private Utilities

5.1 Literature Review

Many research papers have been addressing the question as to whether ownership (public, mixed, or private) is a significant determinant of the efficiency of water supply utilities, or if there are other core determinants such as location and size of the utilities. The large number of empirical and theoretical studies conducted across the United States and Europe that examines various cases and use multiple methodologies show ambiguous, and sometimes contradictory, results. Even though econometric tests mostly favouritise private companies, Still, the majority of case studies do not support the theoretical argument, made by public choice theorists, that privately-owned companies outperform the publicly-owned in efficiency and productivity.

According to E. Pérard, the review of 23 empirical tests and 51 case studies around the world shows that private sector participation does not systematically have positive or negative effects on efficiency (for graphic see Figure 5.1). Thus, the choice between public and private ownership is not just the question of efficient provision (Pérard E. , 2009). An Italian study produced the same results when evaluating 21 private or public-private equity and 32 public equity water service operators shows no influence of the operator typology and service management nature on efficiency (Storto, 2013). However, some papers conclude with evidence stating that the most effective ownership is the PPP model, facilitating both sustainable and efficient operations. Therefore, researchers often ask: Does privatisation solve the constraints regarding financial resources that governments are facing, and does it subsequently improve the productivity of water supply providers?

Greater efficiency, innovation and the possibility of higher investments have been the main arguments for privatisation processes that are based mostly on Agency Theory

and Public Choice Theory.[7] In the Public Choice, there is a certain expectation of private sector outperforming the public. The theory suggests following reasons: in private organisations, managers have a direct connection to the company's financials and they are more likely to benefit from better performance. Contrary to that, public sector actors don't have a direct gain from the increase of their effort and potential success.

Moreover, the theory believes that the private sector has more innovative and productive management practices emerging from the drive of its owners. The core question could consequently be, under what conditions and cooperation scheme can water operators become more effective? The summary of studies on this topic and their results can be found in Figure 5.2.

[7] Agency Theory is expanding the relationship between principals (such as shareholders) and agents (such as company executives) in business. It is trying to solve problems that can exist in agency relationships. In this case the task of owner is to design a contract that provides the manager with the incentive to choose the strategy that maximises the owner's welfare. Public Choice Theory is described as an economic tool how to deal with political and government issues and how could these be solved by set of constitutional rules that constitutional economics deals with. In the ownership issue this theory expects public sector act in their self-interest, for example to increase their own budget.

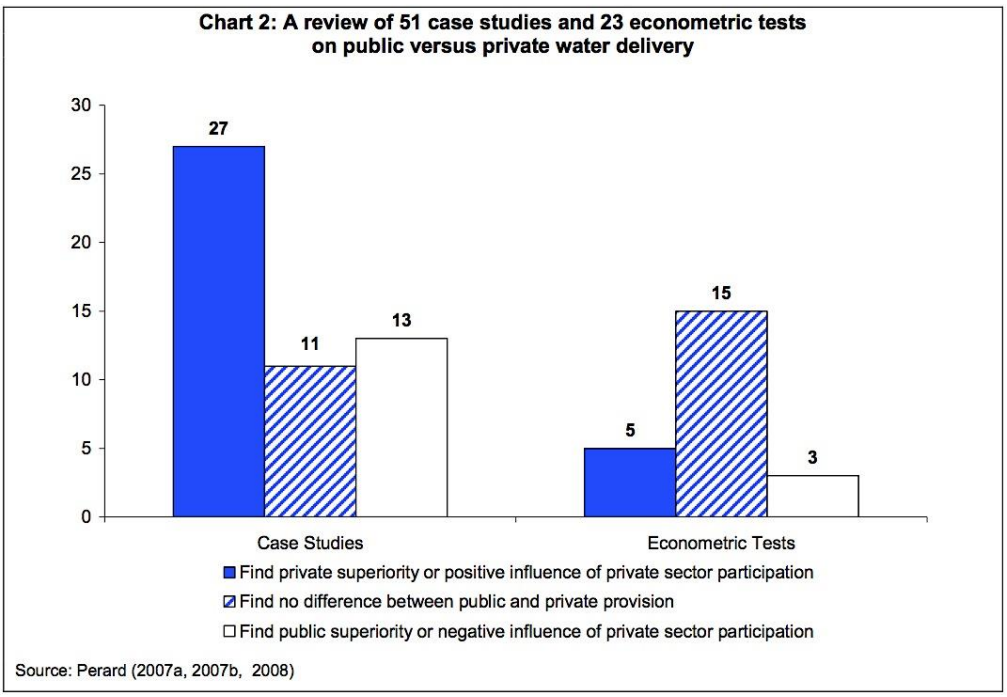

Figure 5.1: Review of OECD Case Studies and Econometric Tests

Source: (Pérard E. , 2009)

Superiority of public management	Superiority of private management	Without significant differences
Mann y Mikesell[1],1976 Bruggink[2], 1982 Lambert et al.[3], 1993 Lynk[4], 1993 Hall y Lobina[5], 2002	Morgan[6], 1977 Crain y Zardkoohi[7], 1978 Raffiee et al.[8], 1993 Bhattacharyya et al.[9], 1995 Estache y Trujillo[10], 2003 Picazo-Tadeo et al., 2007[11], 2009[12]	Feigenbaum y Teeples[13], 1983 Byrnes et al.[14], 1986 Fox y Hofler[15], 1986 Teeples et al.[16], 1986 Teeples y Glyer[17], 1987 Bhattacharyya et al., 1994[18], 1995[19] Aida et al.[20], 1997 Shaoul[21], 1997 Ashton, 2000[22,23] Ménard y Saussier[24], 2000 Saal y Parker, 2000[25], 2001[26] Estache y Rossi[27], 2002 Faria et al.[28], 2005 García Sánchez[29], 2006 Kirkpatrick et al.[30], 2006 Serpa da Motta y Moreira[31], 2006 Saal et al.[32], 2007 Sabbioni[33], 2008

Figure 5.2: Empirical evidence between Private and Public Ownership

Source: (Storto, 2013)

5.2 Evidence from Italy

This subchapter describes the two studies examining the water sector in Italy, publication *The Efficiency of Water Utilities: Does Local Public Ownership Matter? Evidence from Italy* (Silvia Pazzi, 2013), and the article in Water Journal *Are Public-Private Partnerships a Source of Greater Efficiency in Water Supply? Results of a Non-Parametric Performance Analysis Relating to the Italian Industry* (Storto, 2013). Italy is the case where the possibility of water privatisation has been widely debated, and where a 2011 reform has changed regulation and transferred powers to the Italian regions, which can now decide which administrative bodies will be responsible for providing WSS.

In Italy, the water supply is divided into regions that hold established intermediate authority of the governance of water services in each area, called Atority dAmbito Ottimale (ATO), with the aim to exploit economies of scale.

The study by Silvia Pazzi and Co. examines the industry by combining two methods, Data Envelopment Analysis (DEA) and cluster analysis.[8] The study recalls Bozeman (1997) suggestion for 3 dimensions for publicness: Ownership (public, private, mixed), funding (by government or consumer payments), control. These three are closely related; both studies recognise the importance of another two variables on the operators' efficiency: the geographical location of the supplier and its size. From Pazzi's tests, it appears that only size is a significant driver of the efficiency, while ownership and geographical location do not affect it. The paper found a positive relationship between the size of population served and the efficiency levels, therefore recalling the economics of scale theory in the water industry, which corresponds to Storto's results (who also conducted DEA analysis).

Storto calculated in his study that the public operators' total technical efficiency corresponds only to 36%, whereas it is at 51% for the group including both private and mixed operators. The scale efficiency of both groups was on average 90%. Despite this high number, scale inefficiencies are a major concern in both groups and decreasing returns to scale are dominant among public operators. And since the scale

[8] DEA is a non-parametric technique that has the advantage to rank water utilities on bases of their efficiency score without requiring any assump- tion on the distribution function of the data.

is an important factor of efficiency, private sector produces better results in this particular field.

On the grounds of the tests, both studies suggest regulated private or mixed ownership to sustain WSS efficiency. The drinking water sector is known for its high initial and irreversible investments and for the fact that the cost of capital is much higher for the private operators, as well as the cost of debt. All investments are risky and are achievable only when high revenue returns are guaranteed by the tariff system, public subsidies and the eventual re-negotiation of the contract, thus the step that can be taken by the public authority is subsidising these investments. Hence, transferring subsidies to concessionaires may be necessary to keep tariffs low (Storto, 2013).

5.3 The reasoning behind Water Privatization

Eduard Pérard in his *Water Supply: Public or Private?* (Pérard E. , 2009) developed a complete theory of the choice between public and private water supply based on four components: difference of costs of funds (especially the cost of taxes), transaction costs of outsourcing, difference of efficiency and potential political cost of privatising. Efficiency itself depends on the ownership structure, competition and regulation, where adequate regulation plays major role in privatisation.

The transfer of ownership from public companies to private management usually occurs when the public enterprise faces crucial investments in the network, or innovation that they cannot make due to the funding limitations of local governments.

The strong financial restrictions that municipalities face, and unpopularity delivered from increase of tariffs, often explain the decision to privatise (García-Rubio M.A., 2009). This may explain why privatisations lead to increased tariffs. These increases might not be motivated by the search for private profits, but instead by the need for immediate investments and visible network expenses. Public authorities are aiming for power, therefore when unpopular measures such as increasing tariffs needs to be taken; they often transfer the responsibility to private operators, thus maintaining their popularity among population.

Publication *Why privatize? A competition for ownership approach* (Pérard & Rosa, 2007) proposes another explanation for both privatisation and municipalisation movements in general. They "consider that the government's motive is the same as the private investor's motive: to control the firm's profit or cash flow in order to further one's own interests. In the case of the government, the major interests are political power and electoral survival. In order to succeed, any government has to transfer some wealth to supporters, on top of consuming resources by itself. Instead of distributing profits to shareholders or retaining resources for the manager, the state as owner uses the firms' resources to grant rents and advantages to select and useful (to him) clienteles thus aiming at maximising their chances of staying in power. Thus both types of investors, whether private or government, value firms for the cash flow they produce even though the beneficiaries of the cash flow they have in mind are different." Furthermore, they also mention the electoral popularity governments are aiming for, through proper wealth distribution, such as lowering water prices and taxes levied on WSS, increasing quality and subsidies and of course making water accessible for all regardless of their income.

The feasible economic explanation is that the decision of local government to privatise water supply is taken if the private sector offers to pay same or higher concession fee (or set price in case of full divesture) than the present value of future cash flows the public entity could gain operating the WSS, with the same level of tariffs and quality of services (Pérard E., 2009). On final note, privatisation is a choice made when improvement and investments are necessary in the WSS and can only be provided by the private sector. Yet, public authorities are keeping part of the decision power over water operations through tariff regulations, taxes levied on water supply operations, quality minimums and possible subsidisation.

5.4 How could the effectivness be ensured

Supporting the PPPs seems like a legitimate approach in the energy and water sector. Companies would be mostly in private operation overseen by a public authority. As discussed in section 3.1: Competition, assurance of proper competition is almost impossible in the water supply industry. Although, it is achievable to stimulate competition in the water production and final supply distribution among households and to provide fair competition when tendering the infrastructure owner and operator in the first place. It can be compared to the Marshall process on a perfectly competitive market. The assumption is that there is set amount of goods (in our case water supply) that needs to be delivered to the customers no matter what. The coordinator on the market sets up a tendering, similar auction, and the operation of the WSS is offered to the one supplier that places higher bid. In this case, the operation is delegated to the company that offers the highest level of efficiency of market operation. According to basic microeconomic theory, monopolistic companies set the monopolistic price on the level equal their average revenue increasing the tariffs and lowering the quality.

Goverenments can set a price-cap, ensuring an optimal price on the market or putting minimum quotas on the quality of the water. Both of these together are not sustainable for the production companies as a need for government subsidies would be inescapable and often impossible due to the government having delegated the operations to the private sector as a cause of financial constraints in the first place.

Therefore, the idea of ex-ante regulation comes into force. The bidding companies present their plans, investments and the maximum tariff, with the public entity awarding the concession based on that. As a result, the limitation on monopoly revenues is simultaneously ensured.[9] It can be said that it works like this in a comtemporary sense akready, however, the crucial issue is that there is no assurance of future company's proceedings after the bidding. The contracts closed are completely irreversible, despite lasting for more than 20 years. Proper tendering and

[9] Similar competition via regulation works in France, where bidding companies quote the price and the time they are willing to operate under this price level. The operation is then delegated based on that.

fairness is now being discussed and reformed by the EC (see section 3.2.2: The Commission's proposal for a Directive on the award of concession contracts).

With the selection of the operating company made, benchmarking can be applied on its further operation. Benchmarking refers to the assessment of the utilities' performance through measurement of specific indicators in different areas, e.g. customer service, quality, effectiveness, tariffs and efficiency (Oelmann M. & Czichy Ch., 2013). Benchmarking is compulsory for the public municipalities providing water all over Netherlands, and is voluntary or forced by regulatory offices in Germany in order to limit monopolistic power. For private suppliers, compulsory benchmarking by a public authority would ensure affordable tariffs together with effective and improving service, and less corrupted management of big international companies. For this reason, national authorities (something like National Water Office) or Non-Governmental Organisations would have to be established, or appointed, with a responsibility of companies' oversight.

What was briefly mentioned before is the issue of the PPP contracts' long duration. The idea is the introduction of 5-10 years long concessions, subject to re-evaluation and potential contract cancellation. After these 5-10 years, the efficiency of company's management would be evaluated and if sufficient, the contact would be prolonged. In case it was not, new water tendering would take place. Of course the main problem in such cases are the tremendous initial sunk costs into infrastructure and maintenance as well as the increasing price of investments.

Why would a company be interested in shorter contracts where their investments might not be paid off? If the company performed well, their contracts would be prolonged automatically with no other firm taking over then. Therefore the case of Paris, described in Box 2.2 in chapter 2: Ownership in the Water Industry, where SUEZ invested high amount of money and renewed the infrastructure just before their lease expired and public entity took over when crucial investments paid, could not repeat. For this reason increased efficiency in order to stay in business would be expected.

Secondly, rate of return price regulation would be implied together with government subsidies in case of need of extensive investments into infrastructure, sanitation or accessibility of water supply, assuring adequate revenues covering necessary costs.

Government subsidies would also reflect the benchmarking results. This could be a way to imply the cooperation of efficient management, knowledge and ongoing innovation of private sector, with the proper regulation and oversight of public sector.

6 Ownership and Water Tariffs: Multiple Regression Analysis

6.1 Data and Methodology

To estimate the influence of ownership structure (the level of private sector participation) on the tariffs levied on drinking water supply, the econometric model relating the percentage of water supply sector privatised to actual water tariffs and a set of other explanatory variables is employed. This subsection is devoted to the data set description, variables specification and econometric model itself.

6.1.1 Data Set

That data set incorporates data for each of 38 European regions examined. These countries and smaller regions are Austria, Belgium, Prague (CZ), Central Bohemia (CZ), South Bohemia (CZ), Pilsner Region (CZ), Karlovy Vary Region (CZ), Ústí nad Labem Region (CZ), Liberec Region (CZ), Hradec Králové Region (CZ), Pardubice Region (CZ), Olomouc Region (CZ), Moravia-Silesia (CZ), South Moravia (CZ), Zlín Region (CZ), Vysočina Region (CZ), Denmark, Estonia, Finland, France, Germany, Athens (GR), Thesaloniki (GR), non-metropolitan areas (GR), Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Scotland (UK), England and Wales (UK) and Northern Ireland (UK).

It is well-known that each region has more or less different characteristics such as population features (number of people, age structure), geographical features (area, mountainousness), climatic features, and population distribution (proportions of people living in houses and in fats). We predict lower water prices and incomes in poorer or rural regions, and higher water prices and incomes in richer regions. The data are therefore adjusted to per capita or percentage value for further examination.

Moreover, currencies (CZK, EUR, GBP) are converted to USD using exchange rates from December 31st of the corresponding year.[10]

Data sources differ for each variable, as well as for each of the regions. For regions where data is not available, the country's average was used. The data collected reflects years 2006-2008, or the closest year available, and made sure no crucial change regarding water supply ownership happened in these years. Annual water tariffs and regions' average income for the Czech Republic were provided by the *Ministry of Agriculture* and *Czech Statistical Office*, respectively. Data on household drinking water consumption are obtained from the yearbook. Average unit water tariff in Estonia is obtained from OECD individually, for Athens the information was provided by company EYDAP s.a., and for Thessaloniki and non-metropolitan areas of Greece by EYATH s.a. For the all other regions water tariff in 2008 on drinking water supply are from OECD 2010 Studies on Water: *Pricing Water Resources and Water Sanitation Services*, where original Global Water Intelligence data were transformed. Percentage of private sector participation was obtained from individual governments, ministries, companies and special studies. For the Czech Republic, data was calculated by incorporating information from *www.vodarenstvi.com* website providing history of water ownership in each region.

The current expenditure on water infrastructure is taken over from the OECD 2009 publication, where summarised for 2006. OECD also carries the statistics on the total renewable water resources per capita in chapter *Water availability, international comparison* of *OECD Economic Surveys: South Africa 2013* (OECD, March 2013), originally computed by AQUASTAT online database. The average net income per capita can for each country is provided by the European Commission's statistics *Eurostat*, as well as the annual fresh water abstractions for drinking. The description of the dependent and independent variables that enter the water tariff equation can be found below.

[10] All historical exchange rates can be found at http://www.oanda.com/currency/historical-rates/

6.1.2 Variables

Water tariff (USD) Tariff paid for one unit (m^3) of drinking water supplied to a household or private property. Tariff often consists from fixed charge, variable charge and other drinking water charges (varies from country to country). No sewerage and wastewater charges are included, nor are the tariffs for irrigation and other agricultural and industrial use (these tariffs are often lower due to the lower quality of supplied water). Tariff is an average paid in 2008 in given region.

Private sector participation (%) The percentage of water supply and sanitation owned and operated by the private sector. This value includes both fully private companies and PPPs, where the operation and maintenance is in the hands of private provider owning part of the supply. Companies that are in the hands of municipalities are considered as public (even when municipality delegates some tasks to private companies). The private sector participation also in some cases reflects the share of the supplying company owned by private entity.

Expenditure on water infrastructure (USD billion) In order to replace operational costs of water supply on which data are not publicly available, the current expenditure on water infrastructure is used. This expenditure reflects maintenance of water supply as well as investments into higher standard supply.

Abstraction (billion m^3) Annual freshwater abstraction for public water supply from fresh surface and groundwater. This variable is better than the total water consumption of households, because it also reflects the water needed for public spaces and work places. Furthermore water companies need to abstract more water due to high percentage of water leakage and on top of that, taxes and fees of individual water supplier are levied on the amount of freshwater abstracted and not delivered.

Competition (dummy variable) This variable reflects the presence of imperfect competition on the market. Water is often considered as natural monopoly and therefore big international companies can operate huge part of water supply in the region. Some regions managed to control for proper competition leading to lower prices and better effectivity of water delivery on the market. This variable takes on

value 1 when the imperfect competition is present and 0 when the perfect competition holds. When less than 5 companies (providers) operate more than 50% of water supply in the region, competition is considered as imperfect.

Resources (m^3/inhab./year) The amount of total renewable water resources per capita in 2010 in cubic meters is the variable showing the water stress in each region. These include both surface and groundwater.

Net income (USD thousand/inhab./year) The average annual net income per capita in 2008. The income variable shows the poorness/richness of people in the region and therefore it reflects the affordability of water services by its population.

Table 6.1: Data Set Summary

Variable	Number of Observations	Mean	Standard Deviation	Min	Max
Water Tariff	38	2.040	1.433	0	8.610
Level of Private Sector Participation	38	36.984	34.962	0	100
Expenditure	24	3.632	4.766	0.147	17.932
Abstraction	38	1.157	2.135	0.022	9.095
Imperfect Competition	38	0.5	0.507	0	1
Resources per cap.	38	4566.789	4760.827	1081	20503
Price Level	38	90.403	20.391	65.800	137.700
Annual Income	38	19.200	9.275	5.856	43.578

In Table 6.1: Data Set Summary, Stata presents the summary of the dataset. All data from 38 regions were collected, observing seven variables that could have an effect on the water tariff. Yet, the cross sectional data is unbalanced due to incomplete observations for Czech regions, especially missing information about the current expenditure on infrastructure that is not available to the public. Moreover, the average for the whole Czech Republic was used as the data for drinking water resources per capita in its individual regions. It can be done thanks to the small size of the country and the cross regional usage of the water resources. The unbalanced panel should not cause any serious issues in further examination, provided that the missing data is not correlated with the error term *u*.

From the research, the water tariff paid in the European regions is expected to be $2.04 on average, where the most, $8.61 is paid by customers in Denmark and the least is paid by the population of Ireland, where water is provided to the public for free. Regarding the privatization, the percentage of private sector participation scales from 0 to 100%, having the mean at 36.98% level. A completely privatised water supply can be found in the City of Prague and South Bohemia region (CZ), and in England and Wales (UK). Contrary to that, in the rest of the United Kingdom (Scotland and Northern Ireland), Belgium, Pardubice region (CZ), Finland, non-metropolitan parts of Greece and Netherlands, water is fully in the public sector ownership.

The data hereby shows the difference among individual countries regarding the level of water privatization, with one of the reasons for that being the variety of national regulations and laws (e.g. the prohibition of water privatization in Netherlands). The "privatised" number includes both private owned operators and PPPs (same as in (Storto, 2013) publication). The reason provided is the fact that mixed ownership is mostly fully operated and invested in by the private sector and public entity plays a role of regulator (see chapter 2: Ownership in the Water Industry for detailed description of ownership structures).

Connected to the privatization variable is the competition dummy variable, taking on value 1 when imperfect competition is present on the region's water market, and value 0 when the competition appears present. Interesting fact is that the mean of this

variable is 0.5, where exactly half of the regions are facing imperfect competition on the market and the other half is not.

Another big spread lies in the expenditures on water infrastructure. Countries spent on average $3.632 billion on the infrastructure, where the least, $0.147 billion, was spent by Thessaloniki, and the most, $17.932 billion, by Germany. These expenses vary due to the different sizes of examined regions (e.g. comparison of the size of city of Thessaloniki and all Germany), but this does not cause any problem in the model. Size of the regions is important parameter influencing the water tariffs and therefore it is included in most of the independent variables.

Furthermore, regions abstract 1156.585 million cubic meters of freshwater on average, varying extremely again due to the size of the regions. Here the minimum holds Karlovy Vary region (CZ) region having the population of around 310 thousand, extracting only 22.4 million m^3. From the countries, the least is abstracted by Luxembourg, 43 million m^3. Yet, it has to be kept in mind that Luxembourg has international agreements with the Netherlands and Belgium in order to abstract water for drinking from cross-boarder resources. The most water is annually abstracted by Italy, 9094.7 million cubic meters.

Continuing with the description, countries also vary in their freshwater resources per capita from the minimum being 1081 m^3 the minimum in Denmark, being under high level of water stress (that might be one of the crucial reasons behind the highest water tariff in the EU) and 20503 m^3 the maximum in Finland, where it is obvious due to the largest percentage of surface water in the Finnish lakes among European states.

The last 2 variables are here to see whether the tariffs are not influenced by the economic parameters only. Since water is supposed to be affordable to all, the income of population plays major role in tariff settings. The average income of inhabitants in examined countries is equal to around $19200 per year, but the standard deviation is very high showing the variation in living standards around Europe. One would probably guess that the highest annual income receive people in Luxembourg, $43577.51, comparing to the lowest income of $5856.47 a year in Poland.

6.1.3 Theoretical Framework

We estimate our model with multiple regression analysis for cross-sectional data. This analysis allows us to explicitly control for many factors that simultaneously affect the dependent variable. As multiple regression models often accommodate many explanatory variables that might be correlated, we test for multicollinearity and adjust the potentially misleading model by various specifications (dropping some of the problematic variables carefully). This multicolinearity problem causes a bias of t-statistics and influences the significance of the whole regression model. We do the regression using the Stata program in order to get reliable slope estimates for each independent variable, as well as standard deviations and p-value for testing. The key assumption for general multiple regression models is stated in terms of conditional expectation:

$E(u|x_1, x_2, \ldots, x_k)$, where $x_1, x_2, \ldots, x_k$ are explanatory variables.

The fact that unobserved error term u is uncorrelated with our independent variables also means that we have accounted for the functional relationship between explained and explanatory variables. Moreover, our regression has to be linear in parameters, which holds in our case.

From the regression in Stata we obtain the slope estimates, β that measure the partial effect of the corresponding independent variable on the dependent variable, holding all other independent variables fixed. Our model also contains a dummy, or binary, variable, *comp*. We define *comp* to be a binary variable taking on the value one for present imperfect competition and value zero for perfect competition. In our case the name *comp* indicates the presence of competition violation. We use δ as the parameter in order to highlight its interpretation multiplying dummy variable. We test the single hypothesis about the parameters in a model using t-statistics. Moreover, we obtain the value of *R-squared*, which is the proportion of the sample variation in the dependent variable explained by the independent variables, and it serves as goodness-of-fit measure. The problem that we could be facing in the model is omitting a relevant variable causing Ordinary Least Squares (OLS) to be biased. As addition to that we are facing the violation of homoscedasticity assumption. We test homoscedasticity using the Breusch-Pagan test, where in theory the squared OLS

residuals are regressed on the explanatory variables in the model (Wooldridge, 2009). We are also suspecting the model to suffer from low number of observations (n=38 or less depending on model specifications). Even when the heteroscedasticity would be present, we could not correct for it in a small data set (for the data set see Appendix B: Data Set). We estimate multiple regression where u_i is the error term.

6.2 Model and Expectations

We estimate the model:

$$tariff_i = \beta_0 + \beta_1 priv_i + \beta_2 exp_i + \beta_3 abstr_i + \delta_4 comp_i + \beta_5 rescap_i + \beta_6 prclvl_i + \beta_7 inc_i + u_i$$

This model reflects the original regression without any specifications. We will now talk shortly about the variables' expectations.

First of all, the variable that is the most relevant our field of interest in this paper is the level of privatisation. General public would expect the private-sector participation to have had positive effect on the water tariff, both due to the drive for personal revenues of the managers and more reasonably due to the higher investments. Despite the general opinion, our null hypothesis (based on previous studies, see chapter 5: The Evaluation of Performance of Public and Private Utilities) is that the private sector participation does not have a significant positive effect on the water price paid by households. Moreover, PPPs are included as "private" in this variable and therefore public authority still has the option to partially control for overpricing the tariffs.

Our second variable - expenditure on water structure - is expected to have a positive influence on water tariff. Because rationally, when more investments are made and the infrastructure is well maintained and renovated, the expenses and quality of supply will be reflected in the tariffs. Although one can oppose that these investments are often subsidised by the government or funded by the EU, but this only means that the increase of revenue from higher tariffs would be projected on higher income of operating companies.

Likewise, we expect the water abstraction to influence tariffs positively. There are two reasons for such expectation: 1) the more water is abstracted from freshwater resource the higher becomes the level of water stress in corresponding region, 2) with higher abstraction increase also the costs related to it (abstraction fees, taxes, actual procedure of abstraction). The first reason can also explain our fifth variable, resources per capita, reflecting well the water stress in each region. The only dummy variable in our regression - the presence of imperfect competition - is expected to boost the tariff when monopolistic or oligopolistic market structure is present.

Finally, both the average annual income and the price level are also expected to influence water tariff positively. It is known that in the countries with higher individual income the customer goods have in general higher prices, not excepting the energy and water supply tariffs. To conclude, it is noticeable that all of independent variables used are expected to raise the tariff level (except potential presence of proper competition). In the following section the empirical results will either prove the hypotheses or leave the issue open for further discussion.

6.3 Empirical Results: Linear Form

In Table 6.2, we present the results from four specifications of Stata regression analysis of the tariff on all independent variables. For all four cases, we used the multiple regression analysis. Together with coefficients itself, the standard (or robust standard) errors, p-values and overall R-squared are provided. The specifications of individual models were made regarding the correlation between independent variables (reported in Figure 6.1).

The multicolinearity seems to be an issue in our model, but that was expected regarding high connections between inluentials in the industry. The largest, but expected, correlation is between price level and income in referred regions. In our specified models (2), (3) and (4) we decided to use average annual income provided for every individual regions and therefore reflecting the differences between urban and rural areas of the Czech Republic or Greece as well. Furthermore, the resources per capita variable seems to have been correlated with most of the other independent variables, even though any of these values is not exceptionally high.

Table 6.2: Reults of the tariff regression on its explanatory variables

Var./specification	(1)	(2)	(3)	(4)
priv	.0187786* (.0098363)	.0225883** (.0103311)	.0255974** (.0116256)	.010608 (.00802)
exp	.1285204 (.0981338)	.1628177 (.1034884)	.2215866* (.1141375)	
abstr	-.531497** (.2090739)	-.6141232** (.2193924)	-.6374447** (.2483836)	-.082286 (.0991703)
comp	.0621216 (.6982946)	.4001982 (.7243268)	.6584671 (.8122218)	-.1056941 (.5626769)
rescap	-.0001608*** (.0000535)	-.0001382** (.0000559)		
prclvl	.0703714* (0372201)			
inc	-.0330245 (.0722174)	.0962758*** (.0248988)	.0989097*** (.0281892)	.0946802*** (.0233636)
_cons	-2.973891 (2.174117)	-1.281281 (1.787421)	-.4582914 (.78543)	-.021912 (.5777606)
R-squared	0.7118	0.6474	0.5206	0.3537
N	24	24	24	38

Standard deviations in parentheses,
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In our last specification, we face the decision of dropping either abstraction for drinking water supply or expenditure in infrastructure. Despite the fact that expenses of individual operators in the regions are big part of the water tariffs, we are missing data for some of the regions, claiming its confidentiality. For that reason, and because of its explicitness, we are using the total water abstraction variable. While reading the results, we must take into consideration the measurements of each variable, for instance *rescap* are in single m^3/inhabitant compared to *abstr* that is in billion m^3 and for the whole region.

We have also considered specification including all variables but *prclvl* and *exp*, due to their large correlation with other variables, but the resulting model was not usable. It had R^2 only around 0.44, none of the variables reffered as significant expect income and moreover the Breusch-Pagan test rejected homoscedasticity with p-value being 0.000.

	priv	exp	abstr	comp	rescap	prclvl	inc
priv	**1.0000**						
exp	**0.2967**	**1.0000**					
abstr	**0.4856**	**0.8269**	**1.0000**				
comp	**0.6121**	**0.2102**	**0.4674**	**1.0000**			
rescap	**-0.3209**	**-0.4078**	**-0.3976**	**-0.3015**	**1.0000**		
prclvl	**0.0101**	**-0.0014**	**0.0368**	**-0.0221**	**0.0345**	**1.0000**	
inc	**-0.0908**	**-0.0149**	**0.0228**	**-0.1297**	**0.0048**	**0.9359**	**1.0000**

Figure 6.1: Correlation Coefficients

6.3.1 First Specification

Let us start with the first regression model. We estimate the model:

$$tariff_i = \beta_0 + \beta_1 priv_i + \beta_2 exp_i + \beta_3 abstr_i + \delta_4 comp_i + \beta_5 rescap_i + \beta_6 prclvl_i + \beta_7 inc_i + u_i \quad (1)$$

This model is the regression using all variables from the data set. Therefore, the model suffers from multicollinearity. We can also state that the model's goodness-of-fit is quiet high reporting R^2 equal to 71.18%. Moreover, regarding the Breusch Pagan test the model does not suffer from heteroscedasticity. We cannot reject the H_0 stating that constant variance provided the Prob>χ^2 = 0.6483. Hereby the homoscedasticity assumption still holds. This regression provides us with four significant explanatory variables, *prclvl*, *priv*, *abstr* and *rescap*.

The most significant (at 1% significance level) is the amount of resources per capita. The results correspond with our expectation that if the amount of freshwater resources per inhabitant decrease, it means that the water stress in the region becomes bigger problem, and then the tariff increases. That is the same as in the basic microeconomic demand-supply model. The model explicitly states that if the

resources per capita are one cubic meter higher in the region, the water tariff paid by its inhabitants is \$0.00016 lower. Of course this does not seem an extremely small number, but we have to keep in mind the difference of only 1 m^3. For better imagination, if there were 10 more Lake Geneva in Switzerland, Swiss inhabitants would pay only 1.6 dollar cents less per one m^3 supplied to them.[11] Similar to that we report the abstraction variable. When one more billion cubic meters of freshwater is abstracted for water supply, the tariff decreases by around \$0.53. This results is different from our assumption that increased abstraction should also increase the water price due to the water stress. The explanation for abstraction causing decrease in tariff can lie in economics of scale and decreasing marginal operational costs with increasing production.

Furthermore the price level of individual regions plays a major role in forming the water tariffs, if the price level increases by one unit in comparison to the other European countries, the water tariff also increases by \$0.07. It is a well-known fact that water and other consumer goods are more expensive in 'richer' countries.

Finally, how does the ownership of water supply influence the price? Regarding to this specification, in the countries where the private sector participation in water industry is one percentage point higher, the tariff is also higher, by \$0.019. This can be caused by higher investments of the countries or also the fact that water is put into private hands when in need of innovation or renovation.

6.3.2 Second Specification

Continuing with the second specification, we estimate the model:

$$tariff_i = \beta_0 + \beta_1 priv_i + \beta_2 exp_i + \beta_3 abstr_i + \delta_4 comp_i + \beta_5 rescap_i + \beta_6 inc_i + u_i \quad (2)$$

In this specification we dropped the price level (*prclvl*) variable dues to its almost perfect collinearity with annual income variable. Compared to the first regression, the

[11] Lake Geneva in Switzerland has the volume of 89 cubic kilometers, and Switzerland has population of around 8 million. Therefore with 10 lakes, resources per capita increase by 111,25 m^3.

R^2 decreased to 64.74%, which is still good. Dropping *prclvl* raised the significance level of the significant variables in the regression, *inc*, *priv*, *abstr* and *rescap*. Here we basically replaced the influence caused by *prclvl* with the average income variable. The biggest correlation is not present anymore and the regression specification should reflect the reality better.

We will firstly discuss the private sector participation as our point of interest. The coefficient by the *lpriv* shows that if the private sector participation increases by 1%, then the water tariff increases by \$0.0226, in other words if fully public sector was privatised by 100%, the tariff put on water consumption would increase by \$2.26, but that is unlikely to happen (only if we narrow it to individual cities). The variable is significant on 5% significance level (*p*-value is equal to 0.043<0.05) and using the *t*-test, the null hypothesis is rejected. Respecting the influence, it needs to be mentioned that rationally thinking the increase of tariff influence by privatization is rather small and can be a coincidence of low number of observations.

Nevertheless, contrary to the previous model (1), the average level of income explains quiet a big part of the water tariffs (*inc* significant even at 1% significance level). In the regions, where the individual annual income is \$1000 higher, the price paid for water is also higher, by roughly \$0.096. This reflects really well that the good and services' price levels correspond with the 'richness' of inhabitants in examined regions.

The abstraction variable stayed significant in this specification as well. The regions that extract more water by one million m^3, lower their water tariffs by \$0.000614. In this case million is better measurement than billion for imagination (recalling the average amount of water abstracted 1156.6 million m^3). The resources per capita are still a small part of the water price, because in the regions where there is one more $100m^3$ of freshwater available per inhabitant, there the tariff is \$0.014 lower. All in all, water tariffs are affected by level of private sector participation, freshwater abstraction, the amount of resources per capita (though only a small part) and most significantly by annual income levels in the regions.

6.3.3 Third Specification

As a third one, we estimate the model:

$$tariff_i = \beta_0 + \beta_1 priv_i + \beta_2 exp_i + \beta_3 abstr_i + \delta_4 comp_i + \beta_5 inc_i + u_i \quad (3)$$

Where we dropped variables *prclvl* and *rescap*. The R^2 of our model decreased to 52.06%, which still reflects a good-fitted model. Number of observations for this regression is still 24 due to the missing information about expenditure of some regions. The interesting fact regarding this regression is that all variables, except one (*comp*), are statistically significant (referred to *t*-statistic).

First of all, the level of private sector participation shows almost same results as in specification (2), there where private sector owns 1% more on the water market, there the tariff seems to be \$0.0256 higher, therefore we reject the null hypothesis that the private sector is not influential. After dropping *rescap* variable that is mostly correlated with abstraction and expenditure, *exp* becomes significant at 10% significance level. The study shows that if owner spends \$ 1 billion more on the water infrastructure it will be projected in the increase of water tariffs by \$0.222. The general opinion of private sector raising the water prices hereby holds. Although, it can be basically influenced by the fact that private sector has more investments or holds in the regions where innovations need to be made. The parameter that seems to be the most significant is again the annual income. There where average annual net income is by \$1000 higher, there the tariffs are also higher by 0.099\$.

Using the Breusch-Pagan test for heteroscedasticity, the results show constant variance and therefore also in this specification, the homoscedasticity assumption holds. This specification seems to reflect our study the best, since the number of significant variables is satisfactory as well as the R^2 and no significant multicollinearity should be present anymore. In conclusion by this regression (3) we found four main influencers of the water tariff. Apparently, the more private sector participation there is the higher are the tariffs. Likewise, positive influences on the tariff have expenditure and income. Contrary to that, freshwater abstraction is following the theory of economies of scale and projects negative change in the water tariffs.

6.3.4 Fourth Specification

As a last specification, we estimate the model:

$$tariff_i = \beta_0 + \beta_1 priv_i + \beta_2 abstr_i + \delta_3 comp_i + \beta_4 inc_i + u_i \quad (4)$$

Where we additionally dropped the variable of expenditure on water infrastructure. We had two reasons for that, firstly the *exp* variable shows high correlation with abstraction, and secondly it is the variable causing the number of 24 of observation. Despite having 38 observations in this model, the model does not seem to be very good. The R^2 reports that only 35.37% of the change in water tariff is explained by the four explanatory variables we used. Moreover when we compare the *p*-values (and hereby the significance) of individual independent variables, the previous models, especially specification (3) provides us with more useful results. The Breusch-Pagan test for heteroscedasticity strongly rejects the homoscedasticity hypothesis and so we are facing heteroscedasticity problem that would be difficult to solve for such a small sample. Nevertheless in this specification the *p*-value of the annual income per capita is equal to 0.000 and therefore it assures us about the most significant explanatory variable one additional time.

6.4 Conclusion of the Linear Form Specifications

In four different specifications of econometric model we regressed the water tariff on the level of private sector participation, expenditure on water structure, freshwater abstraction, drinking water resources per capita, annual individual income and price level in 38 European regions, various in area, population and development. We tried four different specifications in order to find the most fitted one, avoiding as much multicollinearity as we can and properly reflecting the reality. From our research in this chapter, the specifications (2) and (3) seem to hold the best balance.

We have found that the water tariff is dependent on the level of the water sector privatised. The additional 1% of private ownership and PPP seem to increase the water tariffs on average by $0.023. That rejects our initial hypothesis assuming the ownership does not play an important role. Although as further elaborated in subchapter 2.2: Level of Private Sector Participation, private sector has in general

higher expenses due to better financial resources and the possibility of investments and innovation. The price of water is also highly dependent on the income level in the regions.

In short, the population of richer regions pays more for their drinking water supply. We have also disproved our hypothesis that more water extraction increases the water stress and therefore would have positive dependence with the tariffs. Instead, the amount of water abstraction follows the economies of scale and with increasing abstraction, the price of drinking water decreases. We have also examined the presence of imperfect competition on the market, but the water tariff does not seem to be dependent on that. Our assumption was that if a large company has a majority share on the market, it can set monopolistic water prices. Instead, it looks like that even imperfectly competitive water sectors are regulated enough not to let the small number of participating actors to significantly influence drinking water tariffs.

6.5 Empirical Results: Logarithmic Form

In the previous specification of our regression we showed the unit dependency of the water tariff on all the examined explanatory variables. In this section, we transformed the regression into its logaritmic form in order to have the percentage expression. We can transform all the variables except the level of privatization taking on value zero and the dummy variable of imperfect competition. The *priv* variable is in the percentage points already in the data set, therefore its explanation will be quiet similar as if in the log form.

The regression model is following:

$$ltariff_i = \beta_0 + \beta_1 priv_i + \beta_2 lexp_i + \beta_3 labstr_i + \delta_4 comp_i + \beta_5 lrescap_i + \beta_7 linc_i + u_i ;$$

where u_i is the error term and l expresses the logarithmic form of corresponding variable.

Table 6.3: Empirical results of the logarithmic regression form

Logarithmical form	*ltariff*
priv	.006* (.003)
lexp	.221 (.151)
labstr	-.316** (.137)
comp	-.416** (.180)
lrescap	-.321*** (.100)
linc	.610*** (.120)
_cons	1.411 (1.033)
R-squared	0.758
N	23

Standard deviations in parentheses,
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The empirical results of our new regression are illustrated in Table 6.3, where we can see individual coefficients as well as standard errors and the significance of each explanatory variable. We observe that in this form, five of the dependent variables are significant by the t-statistics.

The variable *linc* is significant at 1% significance level and we can interpret it as 1% increase in population's income refers to the 0.6% increase in tariff. This is a quiet high number and dependence of the water price on the annual average income of the inhabitants in corresponding regions. This can be explained by the 'richness' of individual regions and therefore their affordability of goods and services. In other words, water providers can set higher tariffs on their services in 'richer' regions with water remaining accessible for all.

Another very significant variable seems to be resources per capita. When a country possess of 1% more freshwater resources per inhabitant, its water price is in general 0.3% lower. This reflects the water stress of individual regions. The regions facing water scarcity will set a higher tariff on it as it is with all scarce goods and services in various industries, opposite to those regions which possess plentiful available resources (such as Finland,) which will provide their inhabitants with cheaper water. The companies are behaving in line with the economies of scale theory and the decreasing marginal cost of production. When the companies extract 1% more water from their ground and surfacewater for the regions they provide with the water supply, the inhabitants there pay 0.3% less for unit on average. Therefore the price in the cities should be lower because of higher demand than the price in the rural areas where the number of supplied households is significantly lower. The same theory is applied to big companies serving the whole regions, they put in use the scale production and their marginal cost for additional unit of water supply is lower. Of course this holds keeping other factors fixed (otherwise the cities usually have higher average income that overpowers the abstraction scale influence).

The last two variables in this regression are not in the log form, but nevertheless are significant. The model shows that the difference between perfect and imperfect competition on the market actually changes the price by 41%, which is significant. Despite the assumption, the model states that the water tariff is lower when the imperfect competition is present in the industry. That is interesting, but it can be influence by the size of the region in which certain monopolies are operating and therefore again by the economies of scale. Another explanation can be the inaccuracy in the data, because the variable was made by the number of companies on the market, but without taking into consideration their size (if available, Herfindahl Index for the water industry could be used in further research). Last, but not least is the variable reflecting the ownership of the water supply. In the regions where private companies own one more percantage point of water supply, the tariff is generally 0.6% higher. This rejects our initial hypothesis that the ownership does not have an influence on the water tariffs. As it was explained in the previous chapters, the rise in the tariffs from the side of privately owned entities may be driven by the need of higher investments into water supply and by the need for innovation.

All in all the height of the average annual income and the percentage of water providers privatised influences the price positively, by the rise of 0.6% in the tariff each. On the other hand, the size of available freshwater resources per capita, amount of water abstracted particularly for drinking and the presence of imperfect competition lower the water tariffs. Most significantly the percentage rise in water abstraction and in available resources decreases the tariff by 0.3% each. Except the *comp*, all the variables carried out our predictions.

7 Conclusion

To conclude, the aim of this paper was to bring together the relevant literature in order to create a comprehensible summary of the ownership structures and its effectiveness with regards to water provision. More precisely, this work focused on the drinking water supply for household and the water tariff levied on it.

First this thesis gave background on the various ownership structures in the water industry with detailed identification of the responsibilities of private and public sector in their partnerships. The variety in cooperation between private and public sector was illustrated by examples from Finland, Paris and England. Moreover, the chapter gave a summary of the level of private sector participation in water supply in Europe and an explanation of how PPPs work, being the most effective form. With that in mind, the work continued on with merging the topic of regulation and competition on the market, taking into consideration the monopolistic nature of the industry. In connection to regulation, the EC's proposal for a Directive on the award of concession contracts was defended by the actual goals of the EC of raising the effectivity of ownership contracts and increase in transparency for public tendering. For its importance, the pricing of water for households was summarized as well.

Next, the paper discussed and evaluated the performance of public and private utilities. The literature suggested no difference in effectiveness between private and public entities. Although, the theory believes that the private sector has more innovative and productive management practices emerging from the drive of its owners.

The most important factor of privatization is that the transfer of ownership from public companies to private management usually occurs when the public enterprise faces crucial investments in the network, innovation or lack of know-how. Therefore, supporting the PPPs seems like a legitimate approach in the energy and water sector. The operation is delegated to the private company and the governments regulate the prices and quality and use benchmarking in further evaluation.

Four different specifications were modeled in the multiple regression analysis. In the best specification (2), the tariff regressed on the level of private sector participation, expenditures in infrastructure, freshwater abstraction for drinking supply, presence of imperfect competition, freshwater resources available in the region per capita and on the average annual income of regions' population. We found that an increase in private sector participation leads to an increase in tariffs, although this can be caused by the need for higher investments. Furthermore, the tariff is higher in the regions where people receive higher annual income. Contrary to that, water tariff is lower in the regions where more water is abstracted for the households, due to the advantage of economies of scale. As addition to that, water price also decreases with the increase of the amount of freshwater resources per capita, due to the consequential lower water stress in the region. In the logarithmic form of the best specification we examined the percentage change of the tariff with the change of the explanatory variables. In short, water tariffs are positively influenced by the height of the average annual income and the percentage of water providers privatised. On the other hand, in the regions where the water abstraction or the resources per capita are higher, the water tariff is significantly lower. All of these variables carried out our predictions.

This thesis serves well as an overview in the field of ownership structures in the water supply industry. It provides the essential background and evaluation of public and private entities as well as the model reflecting explanation of the water tariff in selected European countries by multiple relevant factors. Moreover, it summarizes the discussion among multiple economists about the performance of public and private participants in the water provision and an idea of effective PPP. Concerning the future development, the model could be improved with the inclusion of larger amount of observed regions and explanatory variables, such as the cost of provision. Moreover, the Herfindahl Index of the industry in the individual regions could be computed to reflect competition, with focus on big international companies and their influence. Furthermore, the efficiency measures, such as water leakage, quality level or accessibility, can be discussed. Finally, it would be interesting to examine the PPP in order to get most effective water supply for all. Therefore it seems that the future works on this topic will be exciting to follow.

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9 Appendix A: Stata Results

```
. reg tariff priv exp abstr comp rescap prclvl inc
```

Source	SS	df	MS	Number of obs =	24
				F(7, 16) =	5.65
Model	49.3531115	7	7.05044449	Prob > F =	0.0020
Residual	19.980251	16	1.24876569	R-squared =	0.7118
				Adj R-squared =	0.5857
Total	69.3333625	23	3.01449402	Root MSE =	1.1175

tariff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
priv	.0187786	.0098363	1.91	0.074	-.0020735	.0396306
exp	.1285204	.0981338	1.31	0.209	-.0795139	.3365547
abstr	-.531497	.2090739	-2.54	0.022	-.9747139	-.0882802
comp	.0621216	.6982946	0.09	0.930	-1.418197	1.54244
rescap	-.0001608	.0000535	-3.01	0.008	-.0002741	-.0000475
prclvl	.0703714	.0372201	1.89	0.077	-.0085317	.1492745
inc	-.0330245	.0722174	-0.46	0.654	-.1861185	.1200695
_cons	-2.973891	2.174117	-1.37	0.190	-7.582812	1.63503

```
. reg tariff priv exp abstr comp rescap inc
```

Source	SS	df	MS	Number of obs =	24
				F(6, 17) =	5.20
Model	44.8891753	6	7.48152922	Prob > F =	0.0033
Residual	24.4441872	17	1.43789336	R-squared =	0.6474
				Adj R-squared =	0.5230
Total	69.3333625	23	3.01449402	Root MSE =	1.1991

tariff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
priv	.0225883	.0103311	2.19	0.043	.0007916	.044385
exp	.1628177	.1034884	1.57	0.134	-.0555237	.3811591
abstr	-.6141232	.2193924	-2.80	0.012	-1.077001	-.1512457
comp	.4001982	.7243268	0.55	0.588	-1.127998	1.928394
rescap	-.0001382	.0000559	-2.47	0.024	-.0002562	-.0000203
inc	.0962758	.0248988	3.87	0.001	.043744	.1488076
_cons	.8404132	.8696334	0.97	0.347	-.9943528	2.675179

```
. reg tariff priv exp abstr comp inc
```

Source	SS	df	MS	Number of obs =	24
				F(5, 18) =	3.91
Model	36.0976251	5	7.21952502	Prob > F =	0.0142
Residual	33.2357374	18	1.84642986	R-squared =	0.5206
				Adj R-squared =	0.3875
Total	69.3333625	23	3.01449402	Root MSE =	1.3588

tariff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
priv	.0255974	.0116256	2.20	0.041	.0011729	.0500218
exp	.2215866	.1141375	1.94	0.068	-.0182074	.4613806
abstr	-.6374447	.2483836	-2.57	0.019	-1.159279	-.11561
comp	.6584671	.8122218	0.81	0.428	-1.047948	2.364882
inc	.0989097	.0281892	3.51	0.003	.0396864	.1581331
_cons	-.4582914	.78543	-0.58	0.567	-2.108419	1.191836

```
. reg tariff priv abstr comp inc
```

Source	SS	df	MS	Number of obs =	38
				F(4, 33) =	4.52
Model	26.8702465	4	6.71756163	Prob > F =	0.0051
Residual	49.089967	33	1.48757476	R-squared =	0.3537
				Adj R-squared =	0.2754
Total	75.9602135	37	2.05297874	Root MSE =	1.2197

tariff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
priv	.010608	.00802	1.32	0.195	-.0057089	.0269249
abstr	-.082286	.0991703	-0.83	0.413	-.2840495	.1194776
comp	-.1056941	.5626769	-0.19	0.852	-1.250469	1.039081
inc	.0946802	.0233636	4.05	0.000	.0471467	.1422138
_cons	-.021912	.5777606	-0.04	0.970	-1.197375	1.153551

```
. reg ltariff priv lexp labstr comp lrescap linc
```

Source	SS	df	MS	Number of obs =	23
				F(6, 16) =	8.37
Model	5.2018495	6	.866974916	Prob > F =	0.0003
Residual	1.65676781	16	.103547988	R-squared =	0.7584
				Adj R-squared =	0.6679
Total	6.8586173	22	.311755332	Root MSE =	.32179

ltariff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
priv	.0057847	.0029297	1.97	0.066	-.0004261	.0119955
lexp	.2208279	.1510891	1.46	0.163	-.0994667	.5411224
labstr	-.3156514	.1367667	-2.31	0.035	-.605584	-.0257189
comp	-.4156075	.1800686	-2.31	0.035	-.7973359	-.0338791
lrescap	-.3214689	.0998561	-3.22	0.005	-.5331545	-.1097833
linc	.6103836	.1201156	5.08	0.000	.3557499	.8650174
_cons	1.411363	1.032932	1.37	0.191	-.7783557	3.601082

```
. hettest priv exp abstr comp rescap prclvl inc

Breusch–Pagan / Cook–Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: priv exp abstr comp rescap prclvl inc

         chi2(7)      =     6.16
         Prob > chi2  =   0.5208

. hettest priv exp abstr comp rescap inc

Breusch–Pagan / Cook–Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: priv exp abstr comp rescap inc

         chi2(6)      =     6.24
         Prob > chi2  =   0.3972
. hettest priv exp abstr comp inc

Breusch–Pagan / Cook–Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: priv exp abstr comp inc

         chi2(5)      =     6.27
         Prob > chi2  =   0.2808

. hettest priv abstr comp inc

Breusch–Pagan / Cook–Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: priv abstr comp inc

         chi2(4)      =    37.28
         Prob > chi2  =   0.0000
```

10 Appendix B: Data Set

region	tariff	priv	exp	abstr	comp
Austria	2,190	7,00	1,905	0,6079	0
Belgium	4,900	0,00	2,318	0,6973	0
Praha	1,502	100,00		0,1254	1
Stredocesky kraj	1,685	50,03		0,0487	1
Jihocesky kraj	1,679	100,00		0,0370	1
Plzensky kraj	1,348	98,30		0,0333	1
Karlovarsky kraj	1,651	43,29		0,0224	1
Ustecky kraj	1,685	50,10		0,0592	1
Liberecky kraj	1,576	50,10		0,0307	1
Kralovehradecky kraj	1,416	13,21		0,0335	0
Pardubicky kraj	1,354	0,00		0,0311	0
Kraj Vysocina	1,462	33,35		0,0262	1
Jihomoravsky kraj	1,376	33,35		0,0692	1
Olomoucky kraj	1,451	60,00		0,0304	1
Zlinsky kraj	1,519	10,25		0,0322	0
Moravskoslezsky kraj	1,337	98,67		0,0878	1
Denmark	8,610	94,00	1,335	0,4061	1
Estonia	1,120	15,50	0,336	0,0630	1
Finland	1,600	0,00	1,140	0,4080	0
France	3,960	66,70	12,930	5,5188	1
Germany	3,070	33,00	17,932	5,1276	0
Athens (GR)	1,190	39,00	0,728	0,4200	1
Thesaloniki (GR)	1,190	26,00	0,147	0,0690	1
non metropolitan (GR)	1,990	0,00	0,548	0,4676	0
Hungary	1,250	60,00	1,140	0,6407	0
Ireland	0,000	5,90	1,140	0,6090	0
Italy	0,940	52,90	12,150	9,0947	1
Luxembourg	3,550	12,00	0,210	0,0430	0
Netherlands	2,240	0,00	3,577	1,2521	0
Poland	1,280	12,00	9,025	2,1035	0
Portugal	1,310	80,00	1,455	0,9065	0
Slovakia	1,490	0,00	1,539	0,3192	0
Spain	1,170	46,00	7,282	5,7650	1
Sweden	2,150	14,40	1,905	0,8910	0
Switzerland	2,720	0,34	1,725	0,9800	0
Norhern Ireland (UK)	3,070	0,00	0,853	0,2290	0
Scotland (UK)	2,930	0,00	0,601	0,7360	0
England and Wales(UK)	2,570	100,00	5,240	5,9281	1