A Comparative Analysis of the Public and Private Water Supply and Sanitation Service Providers' Work in Brazil

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ABSTRACT

This paper aims to evaluate the performance of the private management of water supply and sanitation services in Brazil. We can verify therefore, whether this management model has presented superior performance compared to the model of public management. The analysis was based on various economic-financial and operational indices related to water supply and sewage collection and treatment between 2000 and 2010. The results indicate that private companies outperform public entities in several aspects, like productivity, investment, return and access to these services, pointing out the concessions and public-private partnerships are feasible ways to reach political targets of universalization of Water Supply and basic Sanitation.

Keywords: Water supply and basic sanitation. Concession. Public-private partnership. Infrastructure.

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1 INTRODUCTION

T he extension and the quality of the infrastructure are determining factors for the development of a country. Ascher and Krupp (2006) state that infrastructure is the backbone of a developed economy and a pillar of quality of life.

The lack of infrastructure investments has been identified in Brazil. According to Pinheiro (*in* OLIVEIRA *et al*, 2013, p. 103), it has been 3 decades since the country invests a little over 2% of its GDP, whilst its direct competitors in the international market and Latin American countries invest from 4% to 8% of

their GDP. Deficiencies in infrastructure greatly affect the population, representing an obstacle to social welfare.

To provide water supply and sanitation infrastructure is a public health issue. The PNUD (2006) (United Nations Development Program) in their Human Development Report, it is observable that worldwide, one million eight hundred thousand children die each year from diarrhea and other diseases, as a result of unsuitable water for human consumption and the and the absence of sewer installations. This is the second leading cause of infant mortality in the early 21st century. Furthermore, investment in water supply and sanitation provides productivity gains and savings of public resources in health, as for for every US$1 invested it is possible to generate a potential benefit estimated between US$5 and US$28, depending on the country (HUTTON; HALLER, 2004).

In order to meet the investment needs, governments have adopted models that lead to a greater private sector participation in the provision of public services, through privatizations, concessions and public-private partnerships. These models have been disseminated by most countries, becoming a widespread and relevant practice within the public sector reform process, being intensified from the eighties.

In this paper four complementary analysis are developed with the objective to verify whether private management of the water supply and sanitation services have presented a higher performance compared to public management, in operational, administrative and financial terms. In addition, we evaluated the willingness to invest and to achieve the goal of services universalization. For this end, we used a database of 1.203 providers of these services in Brazil between 2000 and 2010, this data coming from the SNIS (National Sanitation Information System).

The main contribution of the paper is to verify whether the decisions to delegate management of water supply and sewage services to the private sector provided the expected results, with the objective of universalizing services. Another contribution is to trigger discussion on performance metrics which can be used in periodic reviews of tariffs and contract renegotiations.

The paper is organized over five sections, including this introduction. In the second section we go through the literature review on the theme. The third section presents the methodology and in the fourth section we present the results of the research. In the fifth section are the conclusions of this study.

2 LITERATURE REVIEW

2.1 CONCESSIONS AND PUBLIC-PRIVATE PARTNERSHIPS

According to Evans *et al* (2004), the introduction of the private sector in providing urban water services provides a unique opportunity to address a service economic policy for the poor and informal communities. For Guasch *et al* (2007), from the eighties on, the trend in Latin America and the Caribbean to transfer the provision of public services to the private sector began, due to the need to invest in infrastructure, the scarcity of public resources and from the assumption of greater efficiency of the private sector. These transfers took several forms, such as management contract, concession or privatization.

According to Silvestre (2012) the reasoning for the change in the provision of public sector services to the private sector has its genesis in the belief that there would be more efficiency and productivity and focus on users' needs, when that latter were responsible for the services. According to Bennett (20120, since private companies work in pursuit of profits they would always tend to increase their productivity, achieving higher performance.

It should be admitted that part of the lower efficiency of the public sector stems from the restrictions issued by regulatory standards imposed on the public administrator, or due to the absence of an incentive structure that induces the civil service to achieve higher goals consistently. In addition, Mello (*apud* SHINOHARA; SAVOIA, 2008, p. 4) also cites the agency cost of the public sector, whose governance becomes more complex due to the existence of a third agent, politicians who prioritize maximizing their budgets instead of efficiency, because of the political prestige that it entails.

However, as pointed by Ruester and Zschille (2010), there is no consensus on the best way to achieve this goal among the various modes: public-private partnerships, concessions

and privatizations. This is due to differences among countries in their legislation, practices and institutions that lead to different results among countries.

In sum, private service providers present as advantages: (i) their greater access to the necessary capital in order to invest, given the fiscal situation of states and municipalities making them unable to obtain credit; (ii) insertion into a more flexible legal and regulatory environment, without the binding nature of the Bidding Law, conferring the private sector greater flexibility in the business management; (iii) labor relations without the inefficiencies of the public sector, allowing greater ability to achieve efficiency; (iv) the non-existence of agency cost of the public sector; (v) access to human and material resources in order to seek new technologies that will result in the improvement of the services provided; (vi) their motivation for efficiency gains; and (vii) the competitiveness of the bidding process, which contributes to the practice of reasonable tariffs.

It must be considered that the provision of public services represents the concession to operate a monopoly, and its surrender to the private sector must ensure that the agent keeps the quality of services and the practice of reasonable tariffs. Da Motta and Moreira (2006), who researched the monopoly power of service providers between 1998 and 2002, obtained evidence that, in the absence of incentives for improved efficiency, service providers relieve productivity and apply higher tariffs.

The need for regulation in the sector and proper accountability is emphasized by several authors, such as Locussol (2006), Kessides (2004) and Brocklehurst and Janssens (2004). Seen in these terms, it is appropriate to quote the World Bank's recommendation, in which the pertinent regulation regarding water supply must achieve three goals, of economic and social well-being character: (i) efficiency in production and in supplying water, at the lowest possible cost; (ii) equal access to the entire population at affordable prices and with a quality service delivery; and (iii) sustainability from an environmental viewpoint, to minimize damage to natural resources (KESSIDES, 2004).

It should be noted that the delegation of basic sanitation services to private agents is not risk-free. For example, Uruguay, who had started the sector's privatization in 1993, went back on its decision a decade later due to perceived deterioration of water quality and the high tariffs imposed on the population. These facts led to the enactment in 2004 of a law establishing for such services to be an exclusive assignment of public administration (BORRAZ *et al,* 2013).

It is necessary, therefore to check whether the concessions and public-private partnerships (PPPs) have brought tangible benefits to society, and whether this activity has been conducted by private companies more efficiently. Thus, the justification of this work resides in the investigation of the existence of benefits when conceding public water supply and sanitation services to the private sector, considering the possibility of their better performance, including, the achievement of public policies objectives and of universalization.

2.2 THE EFFICIENCY OF PUBLIC AND PRIVATE WATER SUPPLY AND SANITATION SERVICE PROVIDERS

In international literature, the results of comparisons between the performance of public and private providers are not conclusive. Walter *et al* (2009) produced an extensive literature review to investigate the influence of organizational structure on business performance. Bhattacharyya *et al* (1995 *apud* WALTER *et al*, 2009) studied 221 water supply companies in the US in 1992 and concluded that the public companies have lower costs, and tend to be more efficient than private providers. Etache and Kouassi (2002 *apud* WALTER *et al,* 2009) and Kirkpatrick *et al* (2006 WALTER *et al,* 2009) studied the performance of African water supply companies by means of the Cobb-Douglas production function, using similar data for both studies: as input variables the cost of labor, materials, energy, among others, and as an output variable the volume of water produced; the first study pointed to the greater efficiency of private companies, while the second showed that eventual differences are not significant. García-Sánchez (2006 WALTER *et al,* 2009) conducted a data envelopment analysis of the performance of 24 service providers in Spain considering as predictors variables the staff, the treatment plants, the cost per kilometer; and as dependent variables the amount of water produced and the number of connections; as a result, we found no significant differences between the performance of private and public providers.

Renzetti and Dupont (2003), in their study on the relationship between the origin of the capital and the performance of water supply and sanitation service providers in the US, United Kingdom and France, did not obtain strong evidence that private providers outperform the public providers.

Saal *et al* (2007), studied 10 providers of water supply and sanitation service in the UK between 1985 and 2000, and concluded that efficiency does not stem only from the origin of capital, but also from the regulatory regime. After the sector's privatization, efficiency decreased, due to the changes arising from the privatization itself combined with the   less

restrictive price limits policy (price cap). With the changes in this policy from 1994 onwards, these limits altered and most efficiency losses were recovered.

Brocklehurst and Janssens (2004), when studying the contracts with the private sector in countries from Central and Western Africa, related the period length from the beginning of the PPP contracts to the amount of dedicated staff, per 1000 water connections, and found significant reduction in the workforce, in spite of the distortions caused by illegal connections and the difficulty of measuring the service.

In Brazil, Tupper and Resende (2004) conducted a study on efficiency and regulation, analyzing 20 state companies between 1996 and 2000, by means of data envelopment analysis (DEA). It was found that performance is a function of the system water losses and the density of water supplying services, given by the relation of the population served and the extension of the supply network. The conclusion is that parameters of this nature should be considered in the implementation of mechanisms to encourage competition.

Sabbioni (2008), by examining the efficiency of water supply and sanitation service providers in Brazil between 2000 and 2004, concluded that regional state companies, have the lowest specific costs, which stems from the economy of scale. In addition, local private operators have specific costs similar to those of local public enterprises, while other local public providers have the highest specific costs.

Ferro *et al* (2004) studied the cost structure of the water supply and sanitation service providers between 2003 and 2010 and comment that the administrative independence is not relevant to explain the cost structure but the origin of capital does, since private companies have a lower cost structure. Also according to the authors, independent operators have better cost management and professional training; by contrast, the dependents have subsidies, such as office space, information technology, administration, and others.

3 METHODOLOGY

The research objectives and the methodology used are summarized in Table 1.

Topic	Researched aspect	Research problem	Indexes used	Methodology used
1	Performance analysis	To investigate what providers present better performance , under the economic-financial and operational perspective, according to its legal nature.	Rates of consumption, loss of productivity, financial performance, access to services, etc.	Descriptive statistics and the comparison between the average rates of 2010 service providers.
2	Willingness to invest	To investigate which service providers invest the most.	Amounts invested in concessions in the five years between 2006 and 2010.	Descriptive statistics and comparison between the investments made during the period.
3	Service universalization	To investigate which providers have achieved greater success in the universalization of services.	Evolution of the indexes of access to services between 2005 and 2010.	Descriptive statistics and comparison of the change in rates between 2005 and 2010.
4	Ability to communicate productivity gains	To investigate which providers are better able to communicate productivity gains to rate.	Sanitation public tariffs and indexes of productivity.	Panel Static analysis for the city and for the year of information (2000, 2005 and 2010).

Table 1 - Summary of Research Objectives
Source: Developed by the authors.

On topics 1, 2 and 3, the verification of the significance of the differences between the means of the variables grouped by type of service provider, we used the ANOVA test, whose use is subject to the normality of the variables (HAIR JUNIOR *et al*, 2009; p. 322); otherwise we shall use the Kruskal Wallis' test. The normality test we used the Kolmogorov-Smirnov.

The regression on topic 4 aims to verify the correlation between tariff and productivity indexes, according to the legal nature of the service provider. The dependent variable is the tariff, and the explanatory variables are the selected productivity indexes, individually. We did not consider more than one index per regression given the existing colinearity between the same. Dummy variables were created to identify public sector and mixed capital companies.

The model used is the static panel, indexed by year and by municipality. We used Hausman's test to choose between panels with fixed effects or random effects. Several municipalities do not have information for all years studied, setting an unbalanced panel (STOCK; WATSON, 2004, p.186). The major regression coefficients indicate that the tariff practiced by that provider finds a better explanation in its cost structure, which opens the possibility to share productivity gains with the population served. The existence of significance for the coefficients will be checked by Wald's test. The regression used is shown below:

$$\text{Tariff} = \alpha_1 + \beta_1 \, \text{Vartest} + \alpha_2 \, D_2 + \beta_2 \, D_2 \, \text{Vartest} + \alpha_3 \, D_3 + \beta_3 \, D_3 \, \text{Vartest} \qquad (1)$$

In which:

Tariffs refers to the tariff of water and sewage practiced in the city.

Vartest is the tested productivity index.

D_2 is a dummy for the public sector, including the direct, local authorities and public companies. D_3 is the dummy for mixed capital companies with public and private administration.

α_1 is the intercept

β_1 is the slope (declivity) coefficient of Vartest.

α_2 and α_3 are the coefficients for D_2 e D_3, i.e., the additional intercept for these dummies.

β_2 and β_3 are the coefficients of the interactions between Vartest and dummies D_2 and D_3 and represent the additional declivity on private providers. Along with β1, they will provide answer to the research question.

The interaction between a dummy variable and a continuous independent variable is used in order to check the declivity associated with the dummy (WOOLDRIDGE, 2012, p. 226; STOCK; WATSON, 2004, p.150). Thus, as we intend to measure the correlation between a given index of productivity and the practiced tariff for each sector (public, private, mixed capital), the coefficients of the interaction variables shall provide the desired result.

The analysis conducted only includes data on water supply and sanitary sewage systems. What does not fall under the scope of this study are the treatment of solid waste, cleaning and systems and rainwater harvesting, although they are included in the definition of sanitation in the Law 11.445/2007, which is the regulatory framework for the sector.

All information has been extracted from SNIS (National Sanitation Information System), relating the entrusted supplier of the service (Table 2). In some situations, the SNIS omits the identification of the private concessionaire and relates only the public entity conceding the services.

Table 2 - Number of Records in the SNIS – Water Supply and Sewage Services

Legal nature of the service provider legal	Year		
	2000	**2005**	**2010**
Direct public administration	25	107	700
Regional authority	145	251	406
Private company	13	25	54
Public company	1	6	5
Social organization	-	-	3
Mixed capital company with private management	1	1	2
Mixed capital company with public management	32	32	33
Grand Total	217	422	1203

Source: SNIS. Developed by the authors

4 RESULTS ANALYSIS

The information from SNIS dates back to 1995 and depends on the effort and willingness of municipalities and service providers to feed its database. As shown in Table 2, the number of municipalities records in 2000 corresponds to a fraction of 1/6 of the 2010 quantitative, which shows the revolutionary construction of the database process.

Table 3 shows the income of service providers.

Table 3 - Operating Revenues from Providers in 2010, as to its Legal Nature

Legal nature	Total direct operational revenue (R$/year)	Nº of providers	Average operational revenues (R$)
Direct public administration	297.301.844	700	425.325
Regional authority	4.112.486.092	406	10.154.287
Private company	1.459.212.374	54	27.022.451
Public company	125.097.727	5	25.019.545
Social organization	631.204	3	210.401
Mixed capital company with private management	1.513.584.745	2	756.792.373
Mixed capital company with public management	23.414.831.787	33	709.540.357
Grand Total	30.923.145.773	1203	25.747.832

Source: SNIS. Developed by the authors

Providers may have local, micro-regional and regional coverage. Table 4 provides the profile of the providers on coverage and the percentage of direct operational revenues. In general, mixed capital companies have regional coverage. Other legal natures have eminently local character.

Table 4 – Coverage of the Service Providers – 2010

Legal nature	Coverage					
	Local		**Micro-regional**		**Regional**	
	Nº of providers	**% of Revenues**	**Nº of providers**	**% of Revenues**	**Nº of providers**	**% of Revenues**
Direct public administration	700	100,0%				
Regional authority	402	99,4%	3	0,5%	1	0,1%
Private company	50	79,4%	3	8,9%	1	11,8%
Public company	4	95,6%			1	4,4%
Social organization	3	100,0%				
Mixed capital private management	1	0,2%			1	99,8%
Mixed capital public management	10	4,1%			23	95,9%
Grand Total	1170	21,4%	6	0,5%	27	78,1%

Source: SNIS. Developed by the authors.

4.1 ANALYSIS OF THE PERFORMANCE OF WATER SUPPLY AND SANITATION SERVICE PROVIDERS

Initially we will address the number one research question, consisting of a direct comparison between the contents of the SNIS, which reflect the performance of service providers from optics an economic, financial, administrative and operational viewpoint. For comparative purposes between the average rates, we shall only use information from 2010. Table 5 shows which indexes were used, and for what purpose.

Table 5 - Indexes Used and the Purpose of Analysis

Index	Purpose for its use
IN004 - Average tariff practiced	Verify whether the concession of services to private companies result in higher charges.
IN012 - Financial performance index	Verify if private companies have better management skills than public entities under the administrative and financial perspective.
IN019 - Index productivity: Total active savings with staff	
IN029 - Revenue evasion index	
IN050 - Gross index of linear losses	
IN054 – Revenue days committed to accounts receivable	
IN102 - Total staff productivity index	
IN064 – Operational margin with depreciation	Verify if the private company is able to achieve superior returns to that of public entities.
IN066 - Return on equity	
IN015 - Sewage collection index	Verify that the service provided by private companies is higher than that offered by public entities.
IN016 - Sewage treatment Index	
IN046 - Treated sewage index referring to the water consumed	
IN055 - Total water service index	
IN057 - Water fluoridation index	

Table 6 presents the descriptive statistics of the listed indexes, as wel as Kolmogorov-Smirnov's test, which rejected normality for all variables. Thus, the significance of differences between means may not be based on ANOVA but in the Kruskal Wallis test.

Table 6 – Descriptive Statistics and Normality Test of the Indexes Used

Index	Nº Obs.	Normal parameters		Extreme differences			Kolmogorov-Smirnov Z	Sig. (2 tails)
		Mean	**Standard Deviation**	**Absolute**	**Positive**	**Negative**		
IN004	862	1,159	0,822	0,079	0,077	-0,079	2,330	0,000
IN012	1196	84,158	61,172	0,100	0,100	-0,084	3,470	0,000
IN019	1114	343,090	443,287	0,242	0,242	-0,233	8,067	0,000
IN029	977	3,753	19,410	0,287	0,287	-0,260	8,984	0,000
IN050	978	19,701	26,949	0,232	0,146	-0,232	7,267	0,000
IN054	784	100,449	177,828	0,286	0,219	-0,286	8,010	0,000
IN102	1160	328,079	438,814	0,243	0,243	-0,237	8,282	0,000
IN064	89	18,700	33,192	0,154	0,154	-0,120	1,453	0,029
IN066	86	12,643	256,950	0,324	0,286	-0,324	3,002	0,000
IN015	525	66,890	28,774	0,223	0,091	-0,223	5,119	0,000
IN016	611	51,226	46,372	0,249	0,232	-0,249	6,154	0,000
IN046	524	32,999	35,725	0,193	0,193	-0,178	4,408	0,000
IN055	985	79,305	20,512	0,156	0,156	-0,126	4,912	0,000
IN057	836	59,168	46,043	0,264	0,248	-0,264	7,621	0,000

Table 7 presents the average scores obtained in accordance with the legal nature of the service providers, Kruskal Wallis test and the classification of private companies in relation to the analyzed content.

Table 7 - Average Indexes Observed - 2010

Index	Legal nature							Sig.	H0 (*1)	Classification of private companies	
	Direct Public Adm.	Regional authority	Private company	Public company	Social organization	Mixed capital				General	Relevant (*2)
						Private Adm.	Public Adm.				
Nº obs.	700	406	54	5	3	2	33	-	-	-	-
IN004	0,84	1,26	1,89	1,34	2,11	5,43	2,21	0,000	Reject	4ª	3ª
IN012	61,45	114,58	130,80	146,13	167,82	112,71	93,38	0,000	Reject	3ª	1ª
IN019	411,28	241,31	303,07	286,51	126,29	280,02	342,68	0,000	Reject	3ª	3ª
IN029	6,03	0,06	7,77	14,56	0,00	-0,13	8,42	0,000	Reject	5ª	3ª
IN050	13,92	25,42	16,58	13,18	2,66	17,14	41,22	0,000	Reject	4ª	2ª
IN054	100,55	100,63	71,23	88,00	2,00	50,00	155,34	0,000	Reject	3ª	1ª
IN102	402,41	222,49	257,10	246,77	125,12	225,77	267,57	0,000	Reject	3ª	3ª
IN064			32,65	-17,32	0,00	-21,65	3,85	0,001	Reject	1ª	1ª
IN066			14,93	25,34	-111,11	57,64	9,07	0,322	Accept	-	-
IN015	69,70	67,51	70,05	54,37		61,09	41,79	0,000	Reject	1ª	1ª
IN016	42,94	55,14	80,23	51,27		99,24	68,60	0,000	Reject	2ª	1ª
IN046	32,83	31,60	55,28	20,96		60,62	25,59	0,006	Reject	2ª	1ª
IN055	76,71	82,86	79,18	81,92	57,90	45,77	77,42	0,032	Reject	3ª	2ª
IN057	45,29	73,34	62,76	62,58	43,25	94,00	57,04	0,000	Reject	3ª	2ª

Notes:
a) IN004, IN029, IN050 and IN054 have an inverse classification, that is, the lowest index is more desirable.
b) (*1) H0 represents the hypothesis of which the observations are statistically equal.
c) (*2) Excludes public companies, social organizations and mixed capital companies with private administration, due to the irrelevance of the number of providers classified as such.
Source: SNIS. Developed by the authors

By using as a reference, the classification where the least significant legal natures were excluded, we verified that private providers are located in the first or second position in 9 out of 14 possible situations, which demonstrates its differentiated performance in the evaluated aspects. Private providers have better financial performance, are more efficient in charging, have greater operational margin; at the same time, the concessions which they manage provide more comprehensive services in terms of sewage collection and treatment and are the

second regarding the supply and treatment of water. On the other hand they assume the third place in terms of tariffs practiced. Curiously, they assume only the third place in personnel productivity indexes, whether we are referring to productivity based on the number of active savings (IN019) based on the number of water and sewage connections (IN102).

4.2 WILLINGNESS TO INVEST

One of the reasons to concede services to the private sector resides in the willingness to make new investments, in view of its ability to raise funds. Thus, one aspect to be investigated is: "Does the private partner, in fact, invest more?".

Table 8 presents information available on investments made in the last five years of the past decade (including from 2006 to 2010) distinguishing on the source of funds (service provider, municipality or state government). Note that when the service provider is a private company, the invested public resources are virtually non-existent.

Table 8 - Investments Made in Water Supply in Sanitation - 2006 to 2010

Legal nature	Made by the service provider		Made by municipalities		Made by the State		Total investment
	R$	**%**	**R$**	**%**	**R$**	**%**	
Direct public administration	381.889	94,8	0	0,0	21.125	5,2	403.014
Regional authority	3.844.585	93,8	196.854	4,8	59.198	1,4	4.100.637
Private company	1.416.996	99,4	8.862	0,6	0	0,0	1.425.858
Public company	134.423	100,0	0	0,0	0	0,0	134.423
Social organization	47.192	100,0	0	0,0	0	0,0	47.192
Mixed capital private management	1.920.931	100,0	0	0,0	0	0,0	1.920.931
Mixed capital public management	22.137.945	96,0	30.853	0,1	895.425	3,9	23.064.224
Grand Total	29.883.962	96,1	236.570	0,8	975.748	3,1	31.096.280

Source: SNIS. Developed by the authors

In terms of the amount invested, mixed capital companies are the ones who invest the most. These companies have large dimensions, with average operating revenues of R$ 700 million (Table 3), and manage basic sanitation in the big cities. This comparison should be put into perspective on the municipality's population. Table 9 makes this adjustment, with the *per capita* investment made by the service provider. By this criterion private companies rank the second place among those who invest the most, second only to mixed capital companies with private management.

Table 9 - Average Investment per Capita Made by the Service Provider

Legal nature	Reference year					
	2006	**2007**	**2008**	**2009**	**2010**	**General Mean**
Direct public administration	19,08	20,63	22,40	22,97	23,46	22,24
Regional authority	11,00	19,11	18,77	17,16	18,86	17,10
Private company	50,85	29,60	27,36	24,04	30,87	32,22
Public company	24,38	20,07	6,31	9,81	41,99	20,80
Social organization	-	-	1,77	10,67	2,69	6,45
Mixed capital private management	55,01	37,28	32,98	31,50	41,06	39,57
Mixed capital public management	19,12	16,94	27,40	33,61	36,72	26,70
Grand Total	16,94	20,22	20,88	20,64	22,47	20,50

Notes:
a) We consider only those situations where the investment made in the year differed from zero
b) Kolmogorov-Smirnov's test presented Z = 22.67, or Sig = 0.00; therefore, it must reject normality.
c) Kruskal Wallis test the variable average investment per capita, grouped by the variable legal nature of the provider rejects the hypothesis that the populations are equal, with significance at 0.0001.
Source: SNIS. Developed by the authors.

Of the above, we can claim that private companies invest more, per inhabitant, than all other legal natures, except for mixed capital companies with private management.

4.3 SERVICE UNIVERSALIZATION

In the spirit of Law 11.445 / 2007 to ensure the population access to the services of sanitation, it is justified to assess whether private service providers have shown higher performance in relation to public providers in achieving this goal.

The analysis of the access to services of water supply and sewage collection considered 3 indexes, namely:

- IN015 – Sewage collection index

- IN046 – Treated sewage index referring to the water consumed

- IN055 – Total water service index

Table 10 presents the means of the presented indexes. The water coverage index stood at around 83% in 2005, which means there is little room for growth in access to these services. The index for sewage collection indicates values close to 60% in 2005, which is a long way to the achievement of universal service. With regard to the sewage treatment deficiency is even greater, where the corresponding index reaches 23% on average of the municipalities.

Table 10 - Service Index, by Legal Nature of the Provider

Legal nature	IN015			IN046			IN055	
	2005	**2010**		**2005**	**2010**		**2005**	**2010**
Direct public administration	55,91	69,70		18,77	32,83		81,76	76,71
Regional authority	65,79	67,51		24,24	31,60		84,07	82,86
Private company	55,01	70,05		21,61	55,28		83,50	79,18
Public company	81,08	54,37		25,73	20,96		93,02	81,92
Social organization	50,62	61,09		47,71	60,62		85,84	87,92
Mixed capital private management	39,40	41,79		24,37	25,59		78,63	77,42
Mixed capital public management								57,90
General Mean	60,29	66,89		23,30	33,00		83,17	79,30

Source: SNIS. Developed by the authors.

Growth in access to services will be measured by comparing the 2005 figures with those measured for 2010. Thus, three variables were created:

- Δ_{IN015}: difference of the index of sewage collection between 2005 and 2010;

- Δ_{IN046}: difference of the index of sewage treatment referring to the water consumed between 2005 and 2010;

- Δ_{IN055}, difference of the index of the total water service between 2005 and 2010.

Results are presented in Table 11.

Table 11 – Average evolution in access to services, by legal nature of the provider

Legal nature	Δ_{IN015} Sewage collection	Δ_{IN046} Sewage treatment	Δ_{IN055} Water service
Direct public administration	3,10	5,75	-3,58
Regional authority	2,19	9,13	-0,90
Private company	26,28	39,36	-0,73
Public company	-4,89	10,60	-3,12
Social organization	10,47	12,91	2,08
Mixed capital private management	-2,01	-0,53	-2,76

Notes:
a) By neglecting the records in which the change in nature of the provider occurred, or in which the indexes IN015 IN046 and IN055 did not present valid numbers in 2005 and 2010.
b) Kolmogorov-Smirnov's test presented significances at 0.003, 0.000 and 0.009 for the variables Δ_{IN015}, Δ_{IN046} and Δ_{IN055}, respectively. Therefore, in all cases we must reject normality.
c) Kruskal Wallis' test for the variables Δ_{IN015} and Δ_{IN046}, grouped by the legal nature of the provider, we reject the hypothesis that the means are equal, with significances at 0.013 and 0.000, respectively. The same test supports the hypothesis that equality of the means for the variable Δ_{IN055} with significance of 0.634.

Source: SNIS. Developed by the authors.

With regards to water supply, there is no significance for the difference between the growth of the indexes of the different types of providers, which is justified by the occurring high level of service in 2005. However, private service providers have provided the largest

growth for the indexes related to the collection and treatment of sewage. It is evident, therefore, that public officials should consider the possibility of delegating to the private partner the provision of collection and treatment of sewage services, in order to achieve the goal of universalization of services that the Law 11.445/2007 deals with.

4.4 THE ABILITY TO COMMUNICATE PRODUCTIVITY GAINS

The bidding for hiring a private agent aimed at the provision of public services is a competitive process, causing this agent to reduce their prices until the desired returns limit and pushing them to the constant pursuit of productivity and cost reduction. Public administration has no such motivation, for it prioritizes the bureaucracy, hierarchy and the administrative processes. It is expected that the tariffs practiced by private providers are more correlated to the cost structure than those practiced by public providers.

Productivity gains from concessions open the possibility of reducing public tariffs. Based on this, some regulatory agencies, among which ARSESP (Regulatory Agency for Sanitation and Energy of the State of São Paulo State) (2013), have adopted in the contracts a productivity factor, also called Factor X, whose objective is to share these gains with the population served; thus, this factor is a reducer of the tariff practiced.

If the relationship between tariffs in a given index of productivity is inelastic, the possibility of transferring the benefits to the users of the services is limited and there would be other explanations for the level of tariffs practiced. Take for example, the situation in which the water supply and sanitation services are fulfilled by the direct public administration and that part of the collection with the services is used to fund other public expenditures; thus, other factors that explain the practiced tariff level other than the costs incurred by the water supply and sanitation service.

It should be noted that some rates are directly proportional to the tariff, as those indexes of expenses and losses. In this category are the indexes IN003, IN008, IN026, IN027, IN029 and IN060. Other indexes are inversely proportional to the tariff though, as the productivity and scale indexes. The indexes IN017, IN019, IN048 and IN102 fall into this category. The following tables bring these indexes.

Static panels were processed with fixed and random effect. Table 12 presents the Hausman's test, which indicated the model with fixed effects as the most suitable.

Table 12 – Hausman's Test

Regr.Nº	Independent variable studied (Vartest)	χ^2	Prob$>\chi^2$
	Indexes directly proportional to the tariffs		
1	IN003 - Total expenditure on services per m³ billed	40,76	0,0000
2	IN008 - Average annual expenditure per employee	25,12	0,0000
3	IN026 - Operational expenditure per m³ billed	48,99	0,0000
4	IN027 - Operational expenditure per savings	38,93	0,0000
5	IN029 - Revenue evasion index	13,83	0,0167
6	IN060 – Expenditure index for electricity consumption (water + sewage)	17,44	0,0037
	Indexes inversely proportional to the tariffs		
7	IN017 - Water consumption billed by savings	21,04	0,0008
8	IN019 - Productivity index: active savings per person total (equiv.)	63,80	0,0000
9	IN048 - Produc. index: own employees per 1.000 connections (water + sewage)	89,51	0,0000
10	IN102 - Total personal productivity index (equivalent)	40,84	0,0000

Source: Developed by the authors.

Table 13 presents the coefficients of the static panel with fixed effects among the productivity or expenses indexes (explanatory variables), by the practiced water and sewage tariffs (IN004), the dependent variable. The dummy D_2 was introduced, representative of the direct public administration, regional authorities and public companies; and dummy D_3, relative to the companies with mixed capital with public and private management. As the table's objective is to verify the correlation between a given index of productivity and the value of the tariff, the information of interest in these regressions are the coefficients of the interaction variables β_2 and β_3, and not the constants α_2 and α_3.

Table 13 - Regression Coefficients Between the Productivity Indexes and the Practiced Tariff

		Dependent variable: Practiced tariff – IN004								
Reg. Nº	Vartest	**Coefficient**						R^2	Prob. F	Wald test $\beta_2=\beta_3$ [3]
		Vartest (β_1)	$D_2 \times$ Vartest (β_2)	$D_3 \times$ Vartest (β_3)	Const. (α_1)	D_2 (α_2)	D_3 (α_3)			
		Indexes directly proportional to the tariffs								
1	IN003	0,9118***	-0,0085	-0,1596*	0,1764	-0,0410	-0,0502	0,493	0,000	0,004
		(0,000)	(0,917)	(0,061)	(0,224)	(0,788)	(0,790)			
2	IN008	0,00006***	-0,00003***	-0,00003***	-0,1917	0,6481***	0,6224**	0,219	0,000	0,166
		(0,000)	(0,000)	(0,000)	(0,343)	(0,002)	(0,015)			
3	IN026	1,1457***	-0,2046**	-0,2613**	0,1213	0,0367	0,0275	0,474	0,000	0,355
		(0,000)	(0,049)	(0,018)	(0,430)	(0,820)	(0,889)			
4	IN027	0,0067***	-0,0020**	-0,0022**	0,0983	0,1765	0,0788	0,300	0,000	0,669
		(0,000)	(0,018)	(0,012)	(0,652)	(0,442)	(0,776)			
5	IN029	-0,0142**	0,0151**	0,0117	1,7146***	-0,6886***	-0,6584**	0,044	0,060	0,486
		(0,022)	(0,017)	(0,136)	(0,000)	(0,004)	(0,037)			
6	IN060	0,3333	-0,1551	-0,0629	1,1619***	-0,1030	-0,1236	0,012	0,545	0,883
		(0,585)	(0,802)	(0,942)	(0,000)	(0,749)	(0,800)			

		Indexes inversely proportional to the tariff								
7	IN017	-0,1002***	0,0757***	-0,0109	3,0878***	-1,6273***	-0,0240	0,211	0,000	0,000
		(0,000)	(0,008)	(0,767)	(0,000)	(0,002)	(0,973)			
8	IN019	-0,0027**	0,0030**	0,0077***	2,2812***	-1,3462***	-2,5015***	0,031	0,000	0,000
		(0,044)	(0,030)	(0,000)	(0,000)	(0,004)	(0,000)			
9	IN048	-0,4506***	0,3956***	0,0888	2,7084***	-1,4775***	-0,2167	0,001	0,000	0,000
		(0,002)	(0,008)	(0,594)	(0,000)	(0,003)	(0,723)			
10	IN102	-0,0017	0,0014	0,0065***	1,9224***	-0,7963*	-1,7181***	0,084	0,011	0,002
		(0,233)	(0,330)	(0,003)	(0,000)	(0,076)	(0,006)			

Notes: Significance Level: (***) 1%, (**) 5%, and (*) 10%.
Source: Developed by the authors.

Based on the results from Table 13 we can establish a classification whose rationale is presented in the following examples:

Regression 4: IN0026 refers to operational expenditure and it should be directly proportional to the tariff charged (the greater the expenditure, the greater the tariff to be practiced). The coefficients β_1, β_2 and β_3 are significant, and their values are equal to 1.1457, -0.2046 and -0.2613, respectively. We conclude that β_1 is greater than $\beta_1+\beta_2$, and that β_1 is greater than $\beta_1+\beta_3$. Statistically, β_2 and β_3 are equal, for Wald's test result was 0.3552 for equality between them. We conclude that the private sector has better conditions to reduce tariffs when operational costs are reduced; the public sector though is tied with companies of mixed capital.

Regression 9: IN004, tariff is inversely proportional to IN017, one of the indexes related to productivity or scale (the greater productivity enables the reduction of tariff). The lower the declivity is the greater the possibility to transfer part of this productivity to the user of the service. By construction, β_1 reflects the declivity of the private sector and the declivity of the other sectors should be added to this. In Table 13 we read that $\beta_1 = -0.1002$ and $\beta_2 = 0.0757$, both with significance, and β_3 is not significant. Thus, the declivity of the public sector amounts to $\beta_1 + \beta_2 = -0.0245$, a figure higher than the declivity -0.1002 of the private sector. As β_3 is statistically equal to zero, $\beta_1 + \beta_3$ is statistically equal to β_1 and it is assumed that the declivity of companies is equal to the private sector. Needless to say, that the Wald's test rejects the equality of β_2 and β_3. Thus, we can conclude that, by classifying the sectors according to their ability to transfer greater reduction to the tariff in the hypothesis of economy of scales that index IN017 represents, so we have: first, in a tie comes the private sector and companies of mixed capital; and last comes the public sector.

For the other regressions the procedure follows the same reasoning. Table 14 shows the classification obtained by the private sector, the public sector and mixed capital companies, regarding the declivity obtained in the regressions between price and productivity.

Table 14 – Classification of the Providers, Regarding the Relationship Between Productivity and Tariff

Regr. Nº	Var	Classification		
		Private Sector	**Public Sector**	**Mixed Capital**
Indexes directly proportional to the tariff				
1	IN003	1	2	3
2	IN008	1	2	2
3	IN026	1	2	2
4	IN027	1	2	2
5	IN029	Inconclusive. Prob F > 0,05.		
6	IN060	Inconclusive. Prob F >>0,05.		
Indexes Inversely proportional to the tariff				
7	IN017	1	3	1
8	IN019	1	2	3
9	IN048	1	3	1
10	IN102	1	1	3

Source: Developed by the authors.

From the indexes related to expenses, and thus directly proportional to the tariff practiced, private companies presented higher declivity to those observed in the public sector and in companies of mixed capital for the indexes IN003, IN008, IN026 and IN027. For indexes IN029 (income evasion) and IN060 (electricity consumption) the numbers are inconclusive. Of the indexes related to productivity or scale and therefore, inversely proportional to the practiced tariff, private companies presented higher declivity in module for index IN019, and shared the first position with other sectors relative to indexes IN017, IN048, and IN102.

In sum, out of 10 indexes assessed, private companies presented a greater ability to communicate tariff reduction in eight situations, of which one ties with the public sector and two with mixed capital companies. The public sector presented better performance in one situation, in a tie with the private sector. Mixed capital companies perform better in two situations, both of them tied with other sectors. The indexes IN029 and IN060 present inconclusive results, since Prob. F > 0.05. It can be said therefore that the tariffs of private service providers are more explained by costs or productivity level than the tariffs in the public sector or mixed capital companies.

The lower elasticity observed between tariff and public providers' productivity gains is in line with Da Motta and Moreira (2006), under which the income of the monopolist was not being shared with users for the calculation of the annual gains in productivity, since they do

not explain the annual tariff variations. This decoupling process was more serious for regional operators as are mixed capital companies. It should be noted that at the time (1998-2002), the number of private providers was still incipient. In short, the conducted tests allow the following findings (Table 15):

	Researched aspect	Findings
1	Operational, economic, financial, administrative and tariff performance.	Private companies occupied the first or second position 11 times in 14 possible cases, when confronting directly the selected indexes.
2	Willingness to invest	Private companies are the ones that invest the most except for companies of mixed capital with private management.
3	Service universalization	Private companies have shown the greatest progress towards achieving universal access to collection services and sewage treatment, a particular aspect where Brazil has a greater disability.
4	Ability to communicate productivity gains regarding the practiced tariff	The correlation between the public tariff and indexes denoting productivity was the greatest for private companies, 8 out of the 10 possible cases. In other words, the greater explanatory power of the productivity factors on the tariff enables the communication of productivity gains which favors service users.

Table 15 – Findings
Source: Developed by the authors.

5 CONCLUSIONS

This study sought to comprehensively assess the performance of private companies in charge of providing water supply and sanitation services, compared to those managed by the public sector.

The evidence shows that private providers have a higher performance in several aspects; they are among the companies that invest the most, making them leaders in the quest for universalizing the service; they have, in fact, presented greater gains in the goal of universalizing the access to basic sanitation services; and apparently offer the opportunity to communicate further reductions to tariffs due to productivity gains, which favors finding the solution of Factor X in the concessions of water supply and sanitation.

The findings of this study can serve as a support and incentive for public officials to consider the private sector as an alternative to achieve the goal of Law 11.445/2007, which is to ensure the entire population access to basic sanitation services.

International assessments show no consistent results on the performance of companies in the sector and question social outcomes, as in many cases the private sector presents higher costs and tariffs than the public sector. Thus, competition should be encouraged and, in Brazil, incorporating productivity gain clauses in the concession contracts for basic sanitation,

even for those struck for a longer time, can be an important measure to meet the principle of reasonable tariffs.

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