TEXTO PARA DISCUSSÃO N° 1059

EFFICIENCY AND REGULATION IN THE SANITATION SECTOR IN BRAZIL

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TEXTO PARA DISCUSSÃO

Uma publicação que tem o objetivo de divulgar resultados de estudos desenvolvidos, direta ou indiretamente, pelo IPEA e trabalhos que, por sua relevância, levam informações para profissionais especializados e estabelecem um espaço para sugestões.

SUMMARY

SINOPSE

O marco regulatório do setor de saneamento no Brasil ainda enfrenta a controvérsia sobre em que nível de governo reside o poder concedente e como o setor privado pode operar no setor sem ferir os seus objetivos sociais. Este estudo visa mostrar como essa controvérsia mascara questões mais cruciais associadas ao desempenho produtivo e financeiro do setor. Para tal, estimamos medidas de eficiência e indicadores financeiros que nos permitem analisar em detalhes como as questões de jurisdição e da natureza do capital afetam o desempenho das operadoras de saneamento no país. Em seguida, investigamos como a ausência de instrumentos regulatórios para controle tarifário tem permitido a dissipação da renda mesmo em um ambiente de preços monopolísticos.

ABSTRACT

Regulation in the sanitation sector in Brazil is facing a great deal of debate regarding the government level in which conceding authority should reside and how private operators can fulfill social objectives. The main objective of this study is to show that these issues are not the crucial barriers to the development of the sector when one looks at the productivity performance of the operators. Therefore, we elaborate a detailed analysis of the productivity performance of the current structure of the sanitation sector in Brazil. In doing so, we are able to analyze how jurisdiction of operators as well as the nature of the management, either private or public, has affected performance of the current operators. Moreover, we investigate how the absence of tariff regulation has dissipated efficiencies and allowed the practice of monopolistic tariffs.

1 INTRODUCTION

The sanitation sector presents scale and scope economy characteristics that justify the presence of natural monopolies, particularly in its distribution operations. Indivisible large scale and long-maturity investments thus characterize the sector, that is, activities with "sunk costs".

However, in contrast with other regulated traditional sectors, the sanitation sector is also characterized by low technological dynamism both in production and distribution. However, a wide variation in the adoption of technologies can be observed in each firm for technical (topography, water abundance, etc.) and for management reasons.

Therefore, besides returns to scale, the sector's inefficiency sources should be more dependent on movements toward the frontier ("catch up effects") than properly on frontier movements.

Besides those technologic features, the political organization of the sanitation sector in Brazil is singular both in relation to its similar in the rest of the world and in relation to other regulated sectors in Brazil.

For example, in the Brazilian case, although the conceding authority is municipal, more than 80% of the population is served by state public operators through concessions. Given the precariousness of the regulatory framework, the contracts for these concessions are incomplete in terms of goals, tariff setting and transparency of crossed subsidies.

Additionally, the sector's financing sources are dependent on federal resources. If a latent rejection to private capital insertion with a fragile concessions regime is added to those characteristics, the design and implementation of a regulatory framework becomes far from trivial in this superposition of competences and interests. Not surprisingly, the country does not have a clear and stable regulation for the sector yet.

Once public funds were restricted from the 1990's onward, the sector failed to keep up with its impressive growth that made it possible to expand treated water services to more than 100 million people in 20 years. Therefore, investments have dropped by 30% as an average since 1998.

The absence of a regulatory framework creates barriers and increases costs to the potential private investments in the sector. Privately managed services reach less than 4% of the served population in the country. This is crucial since a considerable investment effort estimated in US$ 60 billion is needed to reach reasonable service coverage goals in the next 20 years.[1]

Apart from the severe fiscal restrictions in the latest years, which have made public resources scarce, the sector had been showing loss of financing capacity since the 1980's when state public operators faced the deterioration of their financing capacity due to the high inflationary processes.

1. As revealed by the Federal Sanitation Autority in its National Sanitation Polict documents.

From the mid-1990's, after the Plano Real, firms failed to recover their financing capacity and tariff policies mostly due to their inefficient management practices protected by a weak regulatory framework lacking compatible incentives for productivity improvements. The private sector, in turn, could not find clear and stable regulatory mechanisms to accelerate its investments.

In 2001 the federal government sent to the National Congress a draft bill proposing a new regulatory framework. According to that proposal, the state would be the conceding authority in metropolitan areas, instead of municipalities. This interpretation was a way to assure the financial viability of state firms by the scale gains to be captured in this territorial base and supposedly used as crossed subsidies to poor municipalities within the area covered by the firm.[2]

To promote the efficiency of services and the participation of private capital, the bill also introduced incentive-based tariffs for monopolistic regulation, such as "price caps" and "yardstick competition". Nevertheless, this bill was weak in terms of governance since it did not set up a specific regulatory agency to apply these instruments.

The bill did not advance due to controversies in its interpretation of the Federal Constitution about the conceding authority of states. Questioning also arose about the role of the private sector, whose fate was believed to be the practice of tariff abuse and the inability to keep an investment pattern that reached poorer areas.

With these concerns in mind, the federal administration that started in 2003 initiated the preparation of a new regulatory framework for the sector in which, among other issues, conceding authority is kept to municipalities when the service is of local interest, and pricing as well as concession procedures are regulated by autonomous authorities. Not surprisingly, the same controversies have stalled the process of drafting that proposal, confronting those supporting municipal conceding power against those willing to preserve the cross-subsidy system generated within the state public operators. In addition to that, the aversion to private capital participation is also presented in the debate.

The main objective of this study is to show that these issues are not the crucial barriers to the development of the sector when one looks at the productivity performance of the operators. Therefore, we will generate a detailed analysis of the productivity performance of the current structure of the sanitation sector in Brazil. In doing so, we will be able to analyze how jurisdiction of operators as well as the nature of the management, either private or public, have affected performance of the current operators. Moreover, we wish to investigate how the absence of tariff regulation has dissipated efficiencies and allowed the practice of monopolistic tariffs.

For that purpose, a summary of the evolution of the sector's regulatory framework is initially presented. Next the literature in productivity measurement in the sanitation sector is overviewed. Then we describe and apply our models to analyze the current performance of water and sanitation services in Brazil considering their territorial scope (state or municipal) and the nature of its

2. Another controversial point was the asset pricing in case of termination of concession contracts with no specific clause.

management (public or private). Based on that we identify sources of technical and scale efficiencies and how those efficiency indicators have affected effective tariff levels.

2 THE PRESENT REGULATORY FRAMEWORK

The sanitation services coverage in Brazil has made great advances in water supply and is already above levels observed in countries of equivalent per capita income. In the sewer services case, on the other hand, we are still below those economies.

Almost 90% of urban households in the country are today served with a treated water system against 61% in 1970. This increased coverage included almost 100 million people into the system in 30 years.

On the other hand, the water supply coverage in rural areas is only 9%. The national coverage of the sewer system doubled in the same period, but it still doesn't cover more than half of the urban population. It should be added that only 27% of the collected wastewater is treated. Regional differences in coverage, in all services, are also persistent.

When services coverage is analyzed by income classes, a rather regressive pattern is observed. The population with an income lower than 2 minimum wages (SM) presents a coverage rate below national average. The higher classes with more than 10 SM, in turn, present a coverage that is 25% higher in water supply and more than 40% higher in sewerage than the lower classes with up to 2 SM.

As can be observed, the sector's investment pattern in the last decades was unable to universalize services either in regional or distributive terms. Institutional and regulatory aspects help to understand these results, as will be next summarized.

Until the 1970's water supply and sanitation services in Brazil were supplied by municipalities under the supervision of the National Health Foundation (Funasa), which was, in turn, supervised by the Health Ministry. In 1971 the National Sanitation Plan (Planasa) was created to take charge of all the sector's investment planning as well as tariff and credit policy and other related norms.

The quality standard of water and sewage collection and treatment were kept in the health and environmental legislations, and enforced by their regulators.

Planasa's main aim was to promote the creation of state firms for water supply and sanitation, encouraging municipalities to make long-term concessions to these firms in exchange for investments granted by the Housing National Bank (BNH), Planasa's financial arm. About 3.200 municipalities among 4.100 adhered to the Planasa. This centralization was justified by the need to reduce the transaction costs of planning and to reach economies of scale, particularly in the fast-growing metropolitan areas.

At the end of the 1980's, the Planasa highly centralized system started to present low performance levels. The tariff regime was no longer appropriate due to a hyperinflationary environment, and the funds for investment were financially weakened by default. The 1988 constitutional reform and its emphasis on decentralization made the Planasa scheme obsolete.

Today, around 80% of the population are assisted by 25 state regional firms. The rest of the market is composed by 255 local operators. In total, the private sector is responsible for only 3.4% of all the served population.

The Federal Constitution of 1988 granted to municipalities the right to make concessions for public services of "local" interest, while acknowledged that federal and state governments should guarantee an efficient and well-regulated water and sanitation services supply. In addition to that, the Constitution requested states to legislate on metropolitan areas. Those constitutional requirements opened debate about what are services of local interest and whether the conceding authority on metropolitan areas should be under municipal or state governments.

In February 1995 the new Concession Law was approved, challenging state firms monopoly, particularly in metropolitan areas. A great majority of the contracts in force were signed in the beginning of the 1970's with the support of Planasa. Therefore, some of them would have their term expired, and others are precarious with practically no specification about important aspects as rules for assets return, performance goals and even investment plans. That precarious aspect of those contracts hinders negotiated solutions for the return of concessions, generating a high level of judicial litigation.

Privatization was also affected by rules about tariff criteria. The Concession Law stated, as well, that the approval of tariff adjustments would be at the conceding party's discretion in the carrying out of contracts. Consequently, it establishes risks for any concessionary when there is no clear and well-defined tariff policy that guarantees contract rights.[3]

In the attempt to settle all those issues, the federal government prepared a new regulatory structure within a law of the National Sanitation Policy. Within this framework management and financial autonomy was established for sanitation firms, as well as behavior rules, tariff policy principles, and concession criteria. It stipulated, however, that states had concession power in metropolitan areas to assure economies of scale and promote inter-municipal cross-subsidies. Although it creates incentives for private concessions and reckons on sophisticated pricing mechanisms, the bill was not clear about governance and no regulatory agency was created for this purpose.

The bill was, however, strongly contested by municipal sponsors of sanitation sectors and due to a great number of questions about privatization related to universal coverage and the possibility of breaking up the vertical structure of privatized services.[4]

The bill did not succeed to be voted and the resulting regulatory weakness creates uncertainties for private investors and discourages investments. With these concerns in mind the federal administration that started in 2003 initiated the

3. A very well known case is the concession of the municipality of Limeira that had the contracted tariff readjustment reduced in 40% by the Mayor's initiative, and sustained in a Federal Court [see World Bank (1999 and 2000)].

4. Another point of dispute has been whether municipalities should reimburse the assets of state firms at the end of concession. In the bill this indemnity would be agreed between the parties, or in the absence of an agreement it would be equivalent to the gross invoicing of three years for later judicial decision.

preparation of a new proposal for the regulatory framework of the sector. Among other issues, this proposal addresses the definition of services of local interest, tariff policy, regulatory authorities and concession procedures. The main economic regulation characteristics of that proposition's final version are the following:

- besides water supply and sewerage services, solid waste and drainage services are also included, all under the common sector now named environmental sanitation.

- as stated in CF 88, municipalities will have conceding authority in services of local interest, to be defined as those of water distribution, sewer collection, solid waste collection and micro drainage;

- other services, such as water capture, water treatment, sewerage, and solid waste treatment and macro drainage, are only of local interest in case of exclusive use of the municipality. Otherwise they are under jurisdiction of the benefited municipalities. In these cases of multiple uses (more than one municipality) a new approach of integrated management is adopted with consortiated conceding authority.

- in case of municipalities that do not operate their own systems, concessions will have to be bided out, either for public or private operators, with clear and specific structure of tariff setting and review, transparent plan of investments and cross-subsidies, and targets for universalization; and

- concessions, either to public or private firms, will be regulated by an autonomous agency.

There are two main gaps in the current proposal for the sector's regulatory framework, namely:

a) There are no specific guidelines for tariff policy and, consequently, pricing rules affecting efficiency and reducing the share of efficiency gains with users may dominate.

b) Although consortiums will carry out integrated management of local and multiple use services, the text does not mention that these arrangements will be also controlled by regulatory agencies.

If these gaps persist, the aim of introducing the so much needed incentives to efficiency and fair tariff levels may not be fully accomplished since such gaps may create room for uncontrolled monopolist power as the one today enjoyed by regional operators.

3 AN OVERVIEW OF THE LITERATURE

As previously mentioned the sanitation sector in Brazil is quite singular. Sanitation service operators are monopolistic concessionaries in their operation area. In Brazil they can be either a state public operator (regional) serving a group of municipalities within a state,[5] or a municipal-based operator serving one (local) or more municipalities (multilocal) that can be either directly managed by the municipality

5. Few major state-owned regional operators have gone public without loosing state-control management.

or by a private operator. That is, the debate in Brazil is not only on private against public management, but also, if not mainly, about municipal against state levels.

The literature on productivity performance in the sanitation sector,[6] however, emphasizes the distinction between private and public management and ownership. For example, this debate in the United States has provided a set of studies [Crain and Zardkooki (1978), Feigenbaum and Teeples (1983), Byrnes, Grosskopf and Hayes (1986); Fox and Hofler (1986), Bhattacharyya, Parker and Raffiee (1994)] developed with data from the American Water Works Association (AWWA).

Apart from methodological divergences, results in the United States have not been able to generalize the dominance of private operators over public ones regarding efficiency. In fact, the latest studies advanced the hypothesis that the tariff policy adopted in the United States based on rate of return to capital has created inefficiencies that dominate the ones expected from public managerial practices. That could be expected since, as shown in Laffont and Tirole (1993), this pricing regime minimizes incentives to efficiency, once it assures that operators will recover any incurred costs.

Estache and Rossi (2002) analyze how public and private water operators perform in the Asia and Pacific Region, and have also found that both show similar efficiency levels. Although they do not apply any quantitative analysis, they indicate that the well-consolidated inefficient tariff setting based on cost recovery could be biasing results.

In Africa, where regulation is weak and politically driven and pricing is only tied in the case of concession contracts, Estache and Kouassi (2002) identify that private operators perform at higher efficiency levels than public ones.

Ashton (2000) shows that privatization increased efficient performance of water operators in the United Kingdom. The same results were found by Estache, Guasch and Trujillo (2003) for Argentina.

Tupper and Resende (2004) is the only study of our knowledge estimating productivity for the Brazilian sanitation sector. The authors, however, only covered state operators, and found that they show differences in productivity levels that could be reduced if proper tariff setting mechanisms were in place.

Therefore, our study will fill the gap in the literature for Brazil, since we will cover the whole sector. We will also contribute by modeling how tariff setting is affected by the absence of monopolistic price control in this special case of the Brazilian sanitation sector, where regulation is absent.

4 THE MODELS

So, for the purpose of our study and limited by our database (a point that will be later discussed), operators will be classified as follows:

6. As well as in other regulated sectors, see, for example, Kumbhakar and Hjalmarsson (1998), Forsund and Kittelsen (1998) and Bagdadioglu, Price and Weyman-Jones (1996) for the electricity sector and Coelli and Perelman (2000) and Cowie and Riddington (1996) for railways and Resende (2000) for the telecommunications.

- Regional operators (*R*): state-owned firms covering several municipalities.[7]

- Autarchic operators (*A*): services directly managed by the municipal administration (in various formats, such as, autarchies, departments, foundations, and micro-regional).

- Private operators (*P*): services operated by private firms offered to one or more municipalities through concessions.

Our main assumption is that there are no sound market mechanisms and incentives in place to regulate pricing, service coverage and investments in the W&S sector in Brazil. Therefore, pressure from users, size of the operator and its institutional format may play a role in terms of productive performance. If so, one could expect that:

a) movements towards the frontier must prevail over and above frontier movements;

b) catch up effects will be stronger in *P* types that were conceded in procurement mechanisms through tariff bidding;

c) types *R* will enjoy economies of scale and greater degree of investment capacity associated to their larger sizes but they are less sensitive to political pressure from users due to their broad state-control management;

d) types *A* instead face stricter political pressure and perceive local lower prices for labor, land and other inputs,[8] and consequently they tend to be more efficient with lower tariff levels than *R* types; and

e) although effective tariff levels practiced by operators may keep a close correlation to their productive levels, the absence of regulation will induce that efficiency gains will be mostly captured by operators and not by users.

In the following subsections we will describe the modeling to test these hypotheses.

4.1 THE MEASUREMENT OF EFFICIENT SCORES

Operators of W&S serve multiple outputs, such as:

- water production;
- water supply (in volume and connections);
- sewage collection (in volume and connections); and
- sewage treatment.

Operators serve these outputs in distinct proportions and costs, and usually at one single price, so direct output/input ratios are not applied for efficiency measurement of each output.

To deal with that, both regression analysis and data envelopment analysis (DEA) are widely used in the literature. The former measures a stochastic frontier

7. Due to data availability, the Tocantins private operator was taken out of the sample.

8. Sometimes they also access more favorable credit schemes.

following specific functional forms, whereas the latter adopts non-parametric techniques. Each approach has its own advantages and disadvantages, as discussed elsewhere.[9] We will, however, opt for DEA since it allows for direct measures of changes of productivity levels overtime.[10]

The efficiency measures are then given by the ratios of the weighted sum of outputs to the weighted sum of inputs (weights are counterparts of the parameters in the regression analysis). The primal problem is to choose these weights subject to the constraint that no firm score is higher than 1.00.

Prices of the inputs paid by each operator are not known, so it is assumed that relative prices are the same for all operators, or, that the input proportions are optimal given the input prices. Here we will consider a special case in which inputs are aggregated by their prices with the aim of deriving overall operation cost efficiency for multiple outputs.

Then the efficiency measure is the distance between the overall operation cost and the output transformation surface. Formally, let $y_k = (y_{1k},.., y_{6k})$ be the six outputs, as previously mentioned (all measured in volume levels and also in connections for water supply and sewage collection) produced by the operators k at the total operational cost x_k. The primal form of DEA would be to identify the weights (μ_i) determining the output surface for each operator m at the time t, as shown in the expression (1) below. The dual approach, instead, as indicated in the expression (2), chooses weights (λ_k) that lead to an explicit efficient measure (θ_m) and with higher degree of freedom since the number of operators is higher than outputs ($p < n$).

$$\text{Max } \sum_i \mu_{it} y_{imt} \quad s.t. \quad \sum_i \mu_{it} y_{ikt} < x_{kt} \qquad k = 1..n; \quad \mu_i \geq 0 \qquad i = 1...6 \tag{1}$$

$$\text{Min } \theta_{mt} \quad s.t. \quad y_{imt} \leq \sum_k \lambda_{ik} y_{ikt} \quad i = 1 \ldots p \quad \theta_{mt} x_{mt} \geq \sum_k \lambda_{kt} y_{kt}; \; \lambda_{kt} \geq 0 \quad k = 1...n \tag{2}$$

The measure (θ_{mt}) is obtained for constant return to scale. Constraining the variable returns to scale approach can be applied constraining (λ_k) to 1.[11]

4.2 THE RELATIONSHIP BETWEEN TARIFF AND EFFICIENT LEVELS

Users of W&S services wish to access good quality services at the lowest cost that can only be attainable by increasing efficiency at production level. In a regulatory environment that pursues efficiency pricing, it is expected that tariff and efficiency levels be negatively correlated and that additional gains in efficiency will be continuously shared with users.

When the regulatory framework lacks the compatible incentives to achieve these welfare results, one could expect that such transfers of efficiency gains might follow other objectives rather than comply with regulated pricing criteria. The highest the

9. See Cubbin and Tzanidakis (1998), for example, for a detailed and applied review.

10. Estimating the same productivity measures with parametric functions, we found a quite similar pattern of distribution of operator types indicating the same conclusions obtained with DEA estimates.

11. For further details, see Coelli (1996 and 1997).

concentration power of the operator, the lower will be the pass through of any efficient gain to users.

In monopolist cases, prices are above marginal costs generating monopolistic rents. Moreover, this lack of competition also reduces incentives for efficiency setting sub-optimal marginal costs. In natural monopoly settings regulation takes place to introduce incentive-based regimes to ensure efficiency gains and their sharing with users.[12]

As mentioned before, once this regulatory framework is absent, the nature of the management (public or private), as well as its jurisdictional coverage (municipal or state level), are expected to affect the relationship between productivity and tariff levels. Once the productivity levels of the operators are known, it is possible to evaluate how the effective tariff levels are correlated to efficiency scores and whether this relationship is affected by operator type.

To test such interactions we applied two models. One model, represented in (3) below, relates tariff levels (w_{kt}) with efficiency levels (p_{kt}) of operators k, controlling by dummies representing types of operators and services. These dummies are: $PM_k = 1$ indicating public management; $RG_k = 1$ indicating regional jurisdiction and $SW_k = 1$ indicating sewage collection services, and with a vector (Z) of variables that describes characteristics of sanitation demand in the region covered by the operator. In the regional case, the variables were aggregated for all municipalities covered by the operator.

$$\begin{aligned}\text{Log}(w_{kt}) = a + bp_{kt} + PM_k(a_n + b_n p_{kt}) + RG_k(a_r + b_r p_{kt}) + \\ + SW_k(a_e + b_e p_{kt}) + Z_k c + e_{kt}\end{aligned} \quad (3)$$

These demand variables in Z are social and economic indicators, such as: per capita income, rate of illiteracy, urban population share and number of served municipalities. Conditioning to them, we will attempt to verify the above-mentioned stylized factors on social control mechanisms that users could use to compensate for the lack of regulatory actions.

To analyze the dynamics of the pass trough of efficiency gains to tariffs, model (4) below applies the same correlation and control variables to gradient measures of tariffs and efficiency scores, also controlling for the same variables.

$$\begin{aligned}\Delta L(w_{kt}) = a + b\Delta L(p_{kt}) + PM_k(a_n + b_n \Delta L(p_{kt})) + RG_k(a_r + b_r \Delta L(p_{kt})) + \\ + SW_k(a_e + b_e \Delta L(p_{kt})) + Z_k c + e_{kt}\end{aligned} \quad (4)$$

Note that private concessions are restricted to municipal jurisdictions so PM = 0 is indicating private operation.

12. For example, yardstick competition with price caps for the revision of tariff levels.

4.3 DATABASE

Our main data source is the National System on Sanitation Information (SNIS) covering the period 1996-2002.[13] This database collects information on the operation of sanitation services all over the country with annual surveys applied to operators. Since operators voluntarily join the system, the database has been expanded throughout the period and so has its coverage of respondents. The number of municipalities served by respondents increased from 3671 in 1996 to 4186 in 2002. In population terms, only from 1998 onwards that coverage was above 90% of the total Brazilian population.

Due to these limitations on coverage, we are going to restrict our analysis to the period 1998-2002. Also, in order to keep a uniform set of respondents and variables throughout the period, operators that did not reveal any of the variables used in the modeling in any of the years of the period 1998-2002 were removed. The final database contained 104 operators, from which 25 serving only water, 20 are regional types and 11 are private concessions.

Total operational cost was deflated by the General Price Index (IGP-OG) and includes not only the operational cost itself but also the expenditure of imported water.

5 EMPIRICAL RESULTS

The dual approach of the DEA model, as indicated in the expression (2) in Subsection 4.1 above, was applied using routines obtained from the site www.une.edu.au/econometrics/cepa based on Coelli (1996). Productivity is then measured with constant (θ) and variable returns to scale (θ^*). So the scale effect (S) is indirectly measured as $S = \theta/\theta^*$.

5.1 COMPARISON ACROSS OPERATOR TYPES

Performance across operator types can be evaluated based on mean values of productivity measures within each group and testing if such mean values are statistically equals using techniques of analysis of variance. Table 1 presents these estimates and tests (with 90% of significance) for each year of the period 1998-2002, including mean tariff values (volume weighted of water and sewage tariffs) for each operator type.

Our results of productivity measures confirm some of our initial hypotheses, as follows:

a) regional and autarchic operators show distinct performances in each year and all measures;

b) scale effects are larger in regional operators and lower in autarchies; and

c) tariff levels are lower in autarchy operators.

Also as shown in Graphs 1 to 3, one can observe that:

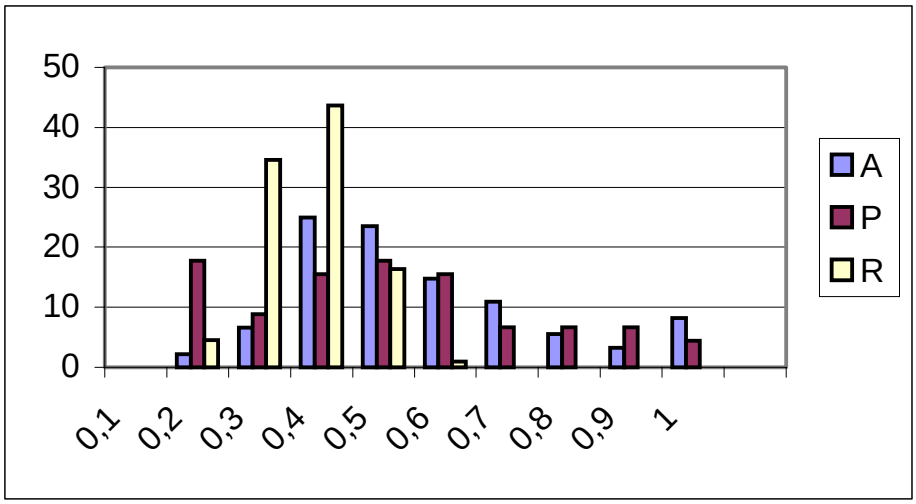
13. In fact, the system starts in 1995, but survey in that year was very limited in coverage and also in data breakdown.

TABLE 1
PERFORMANCE ACROSS OPERATOR TYPES

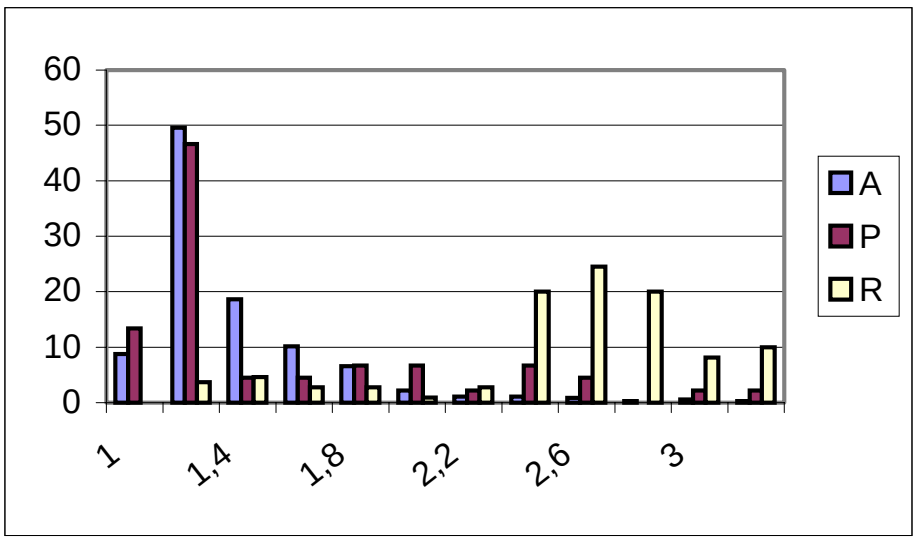
Type/Indicator	θ_{89}	θ_{99}	θ_{00}	θ_{01}	θ_{02}	s_{98}	s_{99}	s_{00}	s_{01}	s_{02}	T_{98}	T_{99}	T_{00}	T_{01}	T_{02}
Autarchy (A)	0.47	0.50	0.54	0.55	0.53	1.24	1.28	1.24	1.33	1.29	0.62	0.54	0.50	0.47	0.41
Private (P)	0.45	0.37	0.47	0.51	0.46	1.43	1.43	1.38	1.49	1.46	0.71	0.72	0.65	0.65	0.58
Regional (R)	0.29	0.33	0.35	0.32	0.33	2.69	2.45	2.31	2.58	2.48	0.93	0.87	0.82	0.77	0.71
R = A?	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
R = P?	N	S	N	N	N	N	N	N	N	N	N	N	N	N	N
A = P?	S	N	S	S	S	S	S	S	S	S	S	N	N	N	N

Note: θ_t = with constant return; s_t= scale effect; and T_t= mean tariff value.

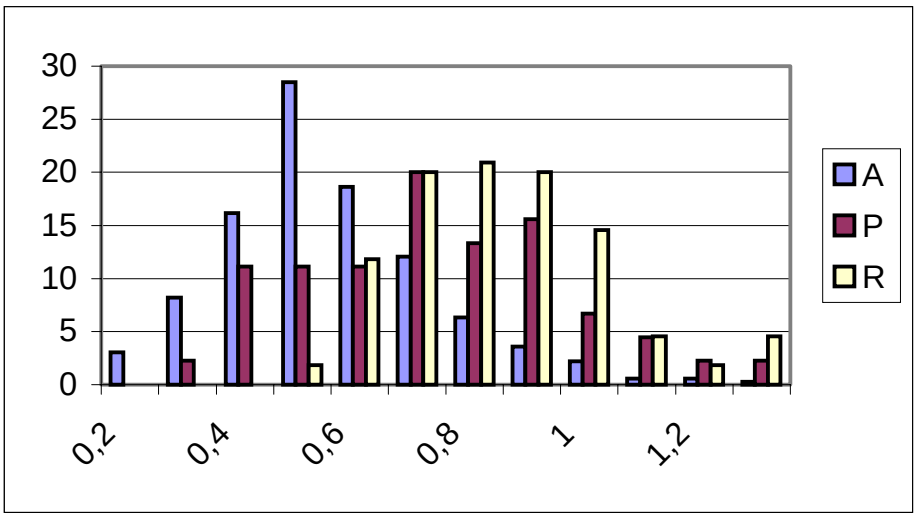
GRAPH 1
DISTRIBUTION PRODUCTIVITY MEASURES BY OPERATOR TYPE — 1998 -2002 (θ_t)



GRAPH 2
DISTRIBUTION OF SCALE EFFECTS BY OPERATOR TYPE — 1998-2002 (S_t)



GRAPH 3
DISTRIBUTION OF TARIFF LEVELS BY OPERATOR TYPE — 1998-2002 (T_t)



a) a high incidence of regional operators at the lowest productivity levels and also at the highest scale effect and tariff levels indicates that in this operator type scale effects are not improving efficiency and lowering tariff;

b) in opposition to that, municipal operators, both autarchies and private, although quite heterogeneous, dominate the highest levels of productivity and the lowest levels of tariffs, and

c) autarchies are clearly showing the lowest scale effects.

In sum, if compatible incentives are in place to promote higher scale production levels of municipal operators and also the internalization of these efficient gains into tariff levels, it is plausible to expect that:

a) overall productivity of the whole sector would be improved; and

b) services from municipal operators could be offered at still lower tariff levels.

5.2 DECOMPOSITION OF ANNUAL VARIATIONS

To analyze the driving forces behind productivity scores through time, we decompose the annual total productivity measure into their components of frontier shifts, technical change and scale effects as follows:

- annual variation of total factor productivity: $\Delta TFP_t = \Delta\theta^{+}_{t}\Delta\theta_t\Delta S_t$;
- annual variation of the scale effect: $\Delta S_t = (S_t/S_{t-1})$ that measures the average effect of scale;
- annual variation of the frontier shift: $\Delta\theta^{+}_{t} = (\theta^{+}_{t}/\theta^{+}_{t-1})$ that measures the movement in the surface of transformation; and
- annual variation of technical change (catch up): $\Delta\theta^{c}_{t} = (\theta^{c}_{t}/\theta^{c}_{t-1})$ that measures how much operators are getting closer to the frontier, at variable returns to scale.

We apply the Malmquist index to estimate these measures and test if mean values are statistically equals (90% of significance) using techniques of analysis of

variance. Results are presented in Table 2 to variations for every year in the period 1998-2002 and also for the whole period.

TABLE 2
DECOMPOSITION OF PRODUCTIVITY MEASURES

Type/Ind.	$\theta\Delta^{\chi}_{99}$	$\theta\Delta^{\chi}_{00}$	$\theta\Delta^{\chi}_{01}$	$\theta\Delta^{\chi}_{02}$	$\theta\Delta^{+}_{99}$	$\theta\Delta^{+}_{00}$	$\theta\Delta^{+}_{01}$	$\theta\Delta^{+}_{02}$	$\Delta\Sigma_{99}$	$\Delta\Sigma_{00}$	$\Delta\Sigma_{01}$	$\Delta\Sigma_{02}$	$\Delta\phi\tau\Pi_{99}$	$\Delta\phi\tau\Pi_{00}$	$\Delta\phi\tau\Pi_{01}$	$\Delta\phi\tau\Pi_{02}$	$\theta\Delta$	$\theta\Delta^{+}$	$\Delta\Sigma$	$\Delta\phi\tau\Pi$
Autarchy (A)	1.11	1.13	1.04	0.97	1.01	0.99	1.07	1.19	0.98	1.03	0.95	1.03	1.11	1.11	1.09	1.15	1.03	1.06	0.99	1.09
Private (P)	0.97	1.25	1.14	0.92	0.99	0.99	1.07	1.23	0.97	1.05	0.94	1.04	0.96	1.23	1.22	1.12	1.03	1.06	0.99	1.09
Regional (R)	1.14	1.06	0.93	1.04	1.04	1.02	1.11	1.13	1.10	1.05	0.90	1.05	1.17	1.08	1.03	1.17	1.04	1.07	1.02	1.11
R = A?	S	S	N	N	S	N	S	N	N	S	N	S	S	S	S	S	S	S	N	S
R = P?	S	S	N	N	S	S	S	N	N	S	S	S	N	S	N	S	S	S	S	S
A = P?	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

Notes: $\Delta\theta$ = catch up; ΔS= scale effect; $\Delta\theta^{*}$ = frontier shift; and ΔPTF = total productivity. Subscript indicating year at the end of the variation period and no subscript means the whole period 1998-2002

The decomposing of the components of total productivity, as shown in Table 2, allows us to confirm other hypotheses, such as:

a) statistically speaking, municipal operators such as autarchies and private types have the same level of variation of total productivity in the whole period;

b) catch up component dominates frontier shifts until 2001 when about ¾ of total productivity is due to catch up effects. The opposite occurs in 2002, with a large shift, resulting that shifts in the frontiers exceed catch up for the whole period; and

c) catch up movements are led by private concessions in 2001, while frontier shifts are equally important in all types.

5.3 THE RELATIONSHIP OF TARIFF AND PRODUCTIVITY LEVELS

As said before, once the productivity levels of the operators are known, it is possible to evaluate how the effective tariff levels are correlated to efficiency scores, and whether this relationship is affected by operator type.

To accomplish that, we have run two econometric models as indicated in expressions (3) and (4) in Subsection 4.2. The first model correlates the levels of tariff (volume weighted of water and sewage tariffs) and productivity for the whole period, whereas the second one correlates annual variations throughout the period.

Regressions are applied with productivity measures at constant returns to scale (*PROD*). In both exercises we control for the type of operator being public management or not (*PM* = 1) and being regional or not (*RG* = 1). Since some operators in the sample do not provide sewage collection, we also control for the existence or not (*SW* = 1) of this service.

Control is also made for demand variables, such as: per capita income (*PCY*), rate of illiteracy (%*ILIT*), urban population (*URBPOP*) share and number of served municipalities (*NM*). Conditioning to them, we will attempt to verify the above-mentioned stylized factors on social control mechanisms that users could use to compensate for the lack of regulatory actions.

Table 3 presents these econometric results, namely, the fitting measure (R^2), the statistical significance of the exclusion of control variables[14] (p-value) and the values of the estimated coefficients (beta).

TABLE 3
RELATIONSHIP BETWEEN TARIFF AND PRODUCTIVITY LEVELS

Models	1		2		3		4	
R^2	0.55		0.55		0.55		0.55	
Standard Error	0.28		0.28		0.28		0.28	
P-value of deletion			96		63		75	
	Models							
Variables	1		2		3		4	
	beta	pvalue	beta	pvalue	beta	pvalue	beta	pvalue
Intercept	0.01	0.96	**–0.08**	0.41	**–0.05**	0.54	**–0.08**	0.18
Prod	**–0.90**	0.00	**–0.88**	0.00	**–0.97**	0.00	**–0.91**	0.00
Ln(NM)	0.10	0.03	0.10	0.02	0.06	0.02	0.06	0.01
SW	0.24	0.00	0.25	0.00	0.25	0.00	0.25	0.00
SW-Produt	**–0.49**	0.00	**–0.49**	0.00	**–0.50**	0.00	**–0.49**	0.00
PM	**–0.23**	0.04	**–0.21**	0.04	**–0.24**	0.00	**–0.21**	0.00
SW-Produt	0.01	0.96	–0.01	0.96	0.08	0.62		
RG	0.11	0.49	0.12	0.43				
RG-Produt	**–0.66**	0.10	**–0.67**	0.09				
PCY	**–0.01**	0.78						
%ILIT	**–0.01**	0.90						
Ln(urbpop)	**–0.01**	0.64						

Notes: 1. variable description in the main text; and 2. Coefficients in bold meaning statistical significance at 95%.

As can be seen in Table 3, results are robust in all models through the depletion process. It can be observed that current productivity level has a negative and statistically significant correlation with tariffs. However, the greater the number of municipalities served by one operator, the lesser is this relationship. That is, operational area over several municipalities restricts tariff reductions due to efficiency level, indicating that economies of scale in regional operators do not moderate tariff levels as expected.

Nevertheless, apart from the number of served municipalities, no other demand-related variables used in the regressions have come out significant.

Serving sewage collection does affect the relationship upward. And public local operators seem, on average, to adjust tariff levels with efficiency levels, perhaps indicating that pricing in concession contracts might have failed to capture productivity-related issues.

14. Exclusion is accepted with p-value higher than 0.

To illustrate how number of served municipalities affect performance, Table 4 simulates how tariff would vary when operator productivity (θ) and number of municipalities covered by operator increase as predicted in our model described in Table 3. As can be seen, observing column values that tariff levels decrease faster with productivity when operator serves a lower number of municipalities.

TABLE 4
SIMULATION OF TARIFF LEVELS WITH PRODUCTIVITY AND NUMBER OF MUNICIPALITIES

N							
θ	1.00	51.00	101.00	151.00	201.00	251.00	301.00
0.2	0.77	0.85	0.87	0.88	0.88	0.89	0.89
0.4	0.64	0.71	0.72	0.73	0.74	0.74	0.74
0.6	0.53	0.59	0.60	0.61	0.61	0.62	0.62
0.8	0.45	0.49	0.50	0.51	0.51	0.51	0.52
1	0.37	0.41	0.42	0.42	0.43	0.43	0.43

Now Table 5 presents the same econometric statistics for the model correlating annual variations of the tariff and efficiency levels.

TABLE 5
RELATIONSHIP BETWEEN TARIFF AND PRODUCTIVITY VARIATIONS

Models	1		2		3		4	
R^2	0.05		0.05		0.03		-	
Standard Error	0.20		0.20		0.20		0.22	
P-value of deletion			86.00		51.69		31.69	
	Models							
Variables	1		2		3		4	
	beta	pvalue	beta	pvalue	beta	pvalue	beta	pvalue
Intercept	–0.09	0.44	–0.03	0.44	–0.09	0.00	0.00	n.a.
Prod	–0.15	0.13	–0.16	0.12	–0.15	0.00	–0.17	0.00
RG	–0.06	0.45	–0.05	0.21	0.01	0.57		
RG–Prod	0.28	0.08	0.28	0.08	0.21	0.12		
PM	–0.07	0.05	–0.07	0.04				
PM–Prod	0.10	0.38	0.10	0.38				
SW	0.01	0.69	0.00	0.94				
SW–Prod	–0.15	0.09	–0.14	0.10				
PCY	0.00	0.92						
%ILIT	–0.04	0.44						
Ln(NM)	0.01	0.86						
Ln(urbpop)	0.02	0.40						

Notes: 1. Variable description in the main text; and 2. Coefficients in bold meaning statistical significance at 95%.
n.a. = not available.

Results in Table 5 are indicating that the model is quite precarious to explain the relationship between variations in productivity and tariff levels. On average, annual variations in the productivity gains over the last years have no explanation power on the annual variations observed in the tariff levels. Therefore, tariff adjustments to efficiency gains, as shown in Table 3 above, are not timely applied when they occur, and they seem to be at the full discretion of operators. Our results only show that regional operators are less prone to speed up any pass through efficiency gains than local operators. Demand characteristics seem not to affect this relationship, since the absence of statistical significance is observed for our demand-related variables.

6 CONCLUSIONS

The debate on the regulatory framework is paralyzed with the controversy to which government level, municipal or state, should conceding power lie. The maintenance of the monopolist power of state firms, and their inter-municipal cross-subsidy schemes, are at jeopardy if capitals and other rich municipalities cease their concession contracts with these firms. So, keeping metropolitan areas under state jurisdiction has become the matter of the controversy. In addition to that, there is reluctance to create a fair business environment to private concessions based on the fear that universalization principles would be at stake.

The sector faces great challenges. The generous flow of public investments occurred in the past that have made possible an impressive expansion of sanitation services in Brazil has been declining with the recent fiscal crisis. Moreover, such constraints seem to remain restricting future investments that were estimated as a saving effort equivalent to 0.5% of the GDP.

Therefore, reliance on private capital is determinant for the development of the sector, although only 3.4% of total population is currently served by private capital. However, the current financial capacity of the sector is undermined.

Indicators from the SNIS show that regional operators show higher wage costs and distribution losses than local operators, although they practice tariff levels almost 60% higher and capture a much higher share in grants for investments than local operators. All this is leading to higher default rates with much lower effective profit margin than local operators.

These indicators also suggest that local operators are financially stronger than regional ones, although tax exemption is benefiting public operators and allowing them to practice much lower tariff levels. Public locals are also passing the investment bill to treasury. While tariff levels practiced by private operators are as higher as the ones practiced by regional operators, only private operators are showing fair profit margins that would sustain investments. In fact, private operators show the same level of service coverage those public locals. Therefore, the fear that private operators may put the sanitation system at risk lacks statistical evidences since they seems the ones that are making the best use of resources.

Identification of production inefficiencies and their sources, therefore, seem to be a crucial policy matter for the sector. This exercise then estimated productivity

measures using the methodologies of data envelopment analysis with the same SNIS database.

Our hypothesis that the lack of regulation in the Brazilian sanitation sector would not stimulate advances in the technological frontier is confirmed by the results. The dominating productivity source is the one moving operator closer to the frontiers since catch up effects dominated total productivity growth in almost the whole period of 1997-2002.

There was also confirmation for the assumption that the insertion of private management of concessions stimulates this effect of getting closer to the frontier, for the results indicated that local private operators led "catch up" effects.

Our results also confirm that regional operators really benefit from economies. However, they are those with the lowest total productivity level. Municipal autarchies, instead, have the highest efficiency levels, and practice lower average tariff levels.

However, when we estimate changes of productivity levels for the analyzed period as a whole, from 1998 to 2002 private and public local operators present the same positive variation of total productivity levels, while regional ones remain lagging behind.

Also, a negative relationship between productivity and tariff levels was found significant, but restricted with the increase of the number of municipalities served, as the case of regional operators. No other demand-related variable, income and education, for example, seem to explain this relationship.

Our results indicate that the monopolistic rent is not being partitioned with users if it occurs when annual productivity gains do not explain annual tariff variations. This uncoupling process is more severe for regional operators, and is not explained by the proxies used to represent demand characteristics.

In sum, productivity gains rather than scale effects are only observed at municipal levels. Since formal regulation is weak, it could be that in the case of autarchies such pattern may be due to informal regulation working through local political pressure and, for private operators, the effect is bound to the requirements in tariff and investment levels tied to contracts.

So, the current debate about conceding power and public versus private management is misplaced. These are issues that currently hinder the evolution of the sanitation sector's regulatory framework in Brazil, but they find no support when the sector's evolution is analyzed. What the evidences brought about in this study are suggesting is that in the absence of incentives for efficiency, operators dissipate their productivity potential and apply higher tariffs. That is to say that the debate on the regulatory framework should be diverted to focus on what instruments should be in place to create incentives to efficiency and increase the sharing of the resulting gains with users. In doing so, the environment for business is restored, allowing for the sustainable and sound expansion of service coverage.

BIBLIOGRAPHY

BAGDADIOGLU, N., PRICE, C. M. W., WEYMAN-JONES, T. G. Efficiency and ownership in electricity distribution: a non-parametric model of the Turkish experience. *Energy Economics*, v. 18, p. 1-23, 1996.

BHATTACHARYYA, A., PARKER, E., RAFFIEE, K. A examination of the effects of ownership on the relative efficiency of public and private water utilities. *Land Economics*, p. 197-209, 1994.

BYRNES, P., GROSSKOPF, S., HAYES, K. Efficiency and ownership: further evidence. *Review of Economics and Statistics*, p. 337-341, 1986.

COELLI, T. *A guide to DEAP version 2.1*. University of New England, CEPA, 1996.

_____. *A multi-stage methodoly for the solution of orientade DEA models*. Armindale: University of New England CEPA, 1997, mimeo.

COELLI, T., PERELMAN, S. Technical efficiency of European railways: a distance function approach. *Applied Economics,* v. 32, p. 1.967-1.976, 2000.

COWIE, J., RIDDINGTON, G. Measuring the efficiency of European railways. *Applied Economics,* v. 28, p. 1.027-1.035, 1996.

CRAIN,W., ZARDKOOHI, A. A test of the property-rights theory of the firm: water utilities in the United States. *Journal of Law and Economics*, p. 395-408, 1978.

CUBBIN, J., TZANIDAKIS, G. Regression versus data envelopment analysis for efficiency measurement: an application to the England an wales regulated water industry. *Utilities Policy*, p. 75-85, 1998.

ESTACHE, A., GONZÁLEZ, M., TRUJILLO, L. What does "privatization" do for efficiency? Evidence from Argentina's and Brazil's railways. *World Development*, v. 30, n. 11, p. 1.885-1.897, 2002.

ESTACHE, A., GUASCH, J. L., TRUJILLO, L. Price caps, efficiency payoff and infrastructure contract renegotiation in Latin America. *Proceedings for The UK model of regulation: a retrospective of the 20 years since the little child report,* 2003.

ESTACHE, A., KOUASSI, E. *Sector organization governance, and inefficiency of African water utilities*, p. 1-21, 2002.

ESTACHE, A., ROSSI, M. A. How different is the efficiency of public and private water companies in Asia. *World Bank Economic Review*, v. 16, n. 1, p. 139-148, June 2002.

FEIGENBAUM, S., TEEPLES, R. Public versus private water delivery: a hedonic cost approach. *Review of Economics and Statistics*, p. 672-678, 1983.

FORSUND, F. R., KITTELSEN, S. A. C. Productivity development of Norwegian electricity distribution utilities. *Resource and Energy Economics,* v. 20, p. 207-224, 1998.

FOX, W., HOFFLER, R. Using homothetic composed error frontiers to measure water utility efficiency. *Southern Economic Journal*, p. 461-477, 1986.

FRIEBEL, G., IVALDI, M., VIBES, C. *Railway (de)regulation: a European efficiency comparison*. 2004, mimeo.

KIM, T. et al. International comparisons of productivity and its determinants in the natural gas industry. *Energy Economics,* v. 21, p. 273-293, 1999.

KUMBHAKAR, S. C., HJALMARSSON, L. Relative performance of public and private ownership under yardstick competition: electricity retail distribution. *European Economic Review,* v. 42, p. 97-122, 1998.

LAFFONT, J. J., TIROLE, J. *A theory of incentives in procurement and regulation.* Cambridge, MA: MIT Press, 1993.

PRICE, C. W., WEYMAN-JONES, T. Malmquist indices of productivity change in the UK gas industry before and after privatization. *Applied Economics*, v. 28, p. 29-39, 1996.

RESENDE, M. Regulatory regimes and efficiency in US local telephony. *Oxford Economic Papers*, v. 52, n. 3, 2000.

ROSSI, M. A. Technical change and efficiency measures: the post-privatization in the gas distribution sector in Argentina. *Energy Economics*, v. 23, p. 295-304, 2001.

SEROA DA MOTTA, R., AVERBURG, A. *Evaluation of the World Bank assistance to the W&S sector in Brazil*. 2002, mimeo.

TUPPER, H. C., RESENDE, M. Efficiency and regulatory issues in the Brazilian water and sewage sector: an empirical study. *Utilities Policy*, v. 12, p. 29-40, 2004.

WORLD BANK. FY90 sector review: water supply and sanitation. *General Operational Review.* Washington, D.C.: Infrastructure and Urban Development Department, 1990 (Report INU, OR6).

WORLD BANK BRAZIL. *Managing pollution problems: the brown environmental agenda, sector report.* Washington, D.C., 1998 (Report, 16.635).

_____. *Regulations for better water and sewerage services*. Washington, D.C., 1999 (Report, 18.568).

_____. *Private participation in the water sector: case studies, lessons and future options, report*. Washington, D.C., 2000 (Report, 19.896).

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