Benchmarking in the Latin American Water Sector:

The Case of Peru

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Abstract

In their process of decentralization, deregulation and privatization of the infrastructure industry, Latin American countries are facing serious difficulties, particularly in the water sector. In Peru, 50 percent of water companies were experiencing financial losses at the time of this research. Management culture and political interference were detected as important issues having an impact in this industry. This study describes alternative measures of efficiency and the implementation of a benchmarking scheme by the sector's regulatory agency. After estimating a regression model for operating costs, a cost frontier is obtained. Results may offer some guidance for future regulatory action in this emerging market.

Key words: Benchmarking, measures of efficiency, regression analysis

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The Latin American Water Sector: The Case of Peru.

In their process of decentralization, deregulation and privatization of the infrastructure industry, Latin American countries face serious difficulties. In the water sector particularly, companies and governments must explain poor performance, inadequate system maintenance, high levels of unaccounted-for water, excess staff, a low rate of metering, and low water quality This study focuses on the water sector of Peru to illustrate how yardstick comparisons can improve sector performance. Unlike the work of Cubbin and Tzanidakis (1998) which applies regression analysis to a developed economy, this analysis draws upon initial data collection efforts in Peru—illustrating the applicability of the framework even for developing economies.

The water and sanitation sector in Peru has undergone several changes that reflect changes in the political system. Since 1990 the water sector has moved from high centralization to a decentralized system under the responsibility of municipalities. In 1992, the government created the regulatory agency SUNASS (*Superentendencia Nacional de Servicios de Sanemiento*) to regulate water and sanitation services provided by municipalities or under private provision. Among other responsibilities, SUNASS was to establish rates that would ensure economic efficiency among companies providing water and sanitation services, *Empresas Proveedoras de Servicios* (EPS). By 1998, 50 percent of the EPS were experiencing losses.

SUNASS is also responsible for restructuring the EPS so that existing companies assume the administration of all their assigned geographic scope and so all the urban area at a national level is receiving service administered by EPS. This goal involves the incorporation of localities within the scope of an existing EPS, the creation of new EPS companies as needed, and the promotion of EPS fusion where feasible.

Although the parameter values that guarantee company sustainability can be determined with an economic exercise by establishing either maximum or minimum values for prices and quantities, targets for service quality are more difficult to determine. Which is better under a budget constraint: 20 hours of continuous service with water quality at 80 percent or 15 hours of continuous service with water quality at 95 percent? Here, quality is measured by some weighted index of monitored quality dimensions related to health and aesthetics. Continuity and "quality" have different impacts on costs and customers value each differently. This research leaves this topic for a later time.

How can SUNASS determine the cause of EPS financial difficulties? What factor or factors make a difference regarding the sustainability of a company? Are the EPS really being inefficient? How can industry observers determine when a company should be consolidated into another one? Are excessive staffing patterns and administrative expenses depriving important operating activities of resources? How can analysts determine what efficiency means in this context?

The economic and political issues facing water utilities are complex and embedded in local institutional settings, but steps must be taken to determine which factors may cause companies to experience financial losses. Although geographical, geological and demographic factors have a great impact on firms in this industry, we can identify management culture and political interference as major issues as well.

Regulators commonly use efficiency indicators such as number of workers per connection and number of connections per population density are commonly to assess utility performance. However, such ratios are not good substitutes for efficiency frontiers, which recognize the much more complex nature of interactions between inputs and outputs. The tendency is to use both efficiency indicators and frontiers to obtain a clear idea of a firm's performance.

The next sections address these issues. Section 1 explains the benchmarking scheme implemented by SUNASS. In Section 2, an analysis of the accounting and operating data of the water sector companies is presented. Next, Section 3 presents results and a discussion of cost determinants. Section 4 presents a regression model for operating costs. The last section provides some concluding observations.

1. The SUNASS Benchmarking Scheme

SUNASS developed a system of efficiency indicators and applied these under a benchmarking scheme with the purpose of stimulating and improving management. SUNASS' expectations were that EPS with low efficiency would gradually reach the level of the most efficient ones. The agency selected nine indicators of efficiency and grouped in three categories: *quality of service*, *management efficiency and efficiency in managing financial issues.* For this initial benchmarking initiative, each indicator has a weight of 1, and since each group has three indicators, the weights of the groups are the same. Companies were ranked on the basis of average percentage points attained.

Each company sets the efficiency indicators within a master plan according to its financial and operational resources. This document is submitted annually to SUNASS for review and approval. Once the master plan is approved, it is viewed as involving mandatory targets. However, there is no penalty under regulatory law if plan objectives are not reached. So at present, the regulations are “indicative” in nature rather than being “rules”.

SUNASS evaluates efficiency indicators on the basis of each company’s rank within a group of EPS, with groupings determined by number of service connections as follows:

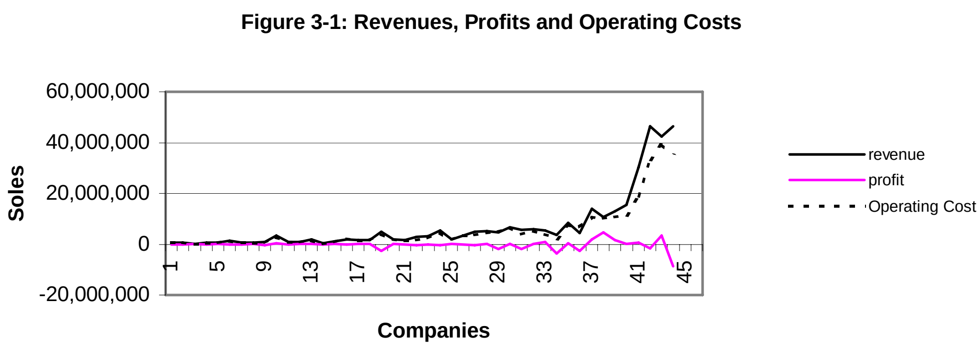
- 17 EPS are *small* with less than 10,000 connections.
- 20 EPS are *medium*-sized, with 10,000-40,000 connections.
- 7 EPS are *big*, with 40,000-160,000 connections.

The EPS (listed by name in Table 1) are located in three different regions: (1) Sierra (Mountain), (2) Selva (Forest) and (3) Costa (Coast). SEDAPAL, the water and sanitation utility of Lima, is not included in this study since its high number of connections (959,356) would distort the results. Additionally, SEDAPAL is not under direct regulatory responsibility of SUNASS. For a detailed analysis of this EPS, see Alcazar, Xu and Zuloaga (2000); problems that Alcazar et al. mention in their study are basically the same as those detected with the efficiency indicators analysis.

SUNASS published the results of the benchmarking in 1999. One of the difficulties faced by the regulator in Peru in analyzing the data is the heterogeneity of the EPS. The potential performance of a company with 40,000 connections may not be the same as that of a company with 120,000 connections, yet they are in the same group.

A general idea of relative performance can be seen in Figure 1, which shows revenues, profits and operating costs for all EPS. The monetary data is expressed in *soles*, the national currency of Peru. We can see that levels of revenues and operating costs are unrelated to size within each group of companies. For instance, company 3 has 2,778 connections and almost the same level of revenue, profits and operating costs as company 14, which has 6,496 connections. We also observe the small operating margins (revenues minus operating costs, not including depreciation) of these companies. The group of big EPS shows a wider operating margin, which decreases with number of connections. Overall, 50 percent of the EPS were experiencing negative profits by 1998.

Figure 1: Revenues,Profits,Operating Costs by Company



It is not easy to give a precise diagnosis about inefficiencies without a specific technique to evaluate relative efficiency as reflected in costs and production technologies. Nevertheless, considering the common problems of the water sector, we will first explore the relations among some of the variables available. From the efficiency indicators selected by SUNASS, I focus on *quality of water* (chemical standard treatment) measured as a percentage, *continuity* of service measured in hours, *coverag*e (number of connections divided by total population in the area) as a percentage, and *morosidad* (number of accounts receivables divided by number of bills) expressed in months. Other variables from the accounting data of each company for the period 1996-98 are also used.

2. Analysis of the Data

Total Cost

Total cost is the sum of operating and finance costs. *Operating cost* is conformed by sales cost, sales expenses, administrative expenses, depreciation and provision for uncollectables. *Finance cost* includes finance expenses plus amortization on debt. Finance costs represent less than 10 percent of total cost in 57 percent of the EPS. Finance costs are linearly related to the amount of total debt (short- and long-term) of each company.

Energy cost is included in sales cost. Salary expenses are distributed in sales cost, sales expenses and administrative expenses according to the type of work performed and whether it is under a contract. We are interested in two types of analysis in this study. On one hand, the composition of total cost regarding the proportion of its elements is examined. On the other hand, unit costs are analyzed. To obtain unit cost per annual cubic meter of water produced, each cost is divided by annual volume of water produced. The proportion of each element of cost may show us possible areas of managerial weakness in finance. Since the difference between water produced and billed is significant, unit costs may give us an indication of the incidence of this difference in company performance.

Administrative expenses represent more than 25 percent of operating costs in 73 percent of the EPS. In six of the small EPS and five of the medium-sized ones, administrative costs represent more than 40 percent of operating costs. However, unit administrative expenses are higher than 40 percent in just four EPS.

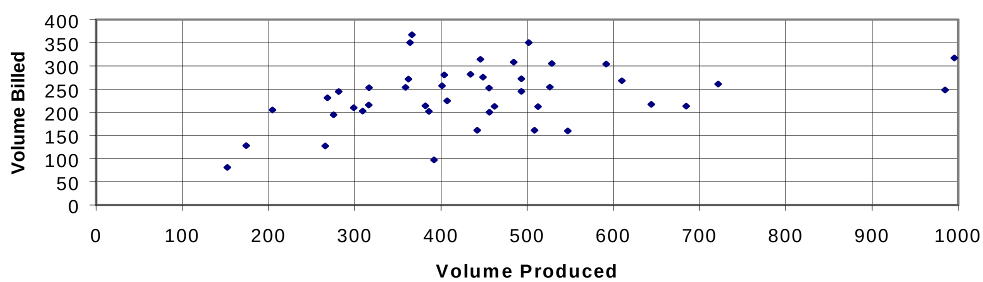
Salary expenses represent more than 40% of operating costs in 66 percent of the EPS, of which eleven are small, fourteen are medium-sized and four are big. At unit salary expense level, just 29 percent of the EPS have a value greater than 40 percent.

Excess staff may contribute to the low productivity of these EPS. A ratio equal or greater than six employees per 1,000 water connections is found in 40 percent of the EPS. A ratio of two to three employees per 1,000 connections is found in an efficient water company. The ratio of employees per 1,000 connections is linearly related to the ratio of salary expenses and number of connections.

Unaccounted-for Water

The ratio of volume of water billed to volume of water produced gives us a measure of water not accounted for. Figure 2 shows this relation. We should expect the EPS to lie on a 45-degree line indicating that water produced is also billed, but the graph shows a different story. Sixteen of the EPS (36%) have more than 50 percent of water not accounted for.

Figure 2: Water Billed to Water Produced

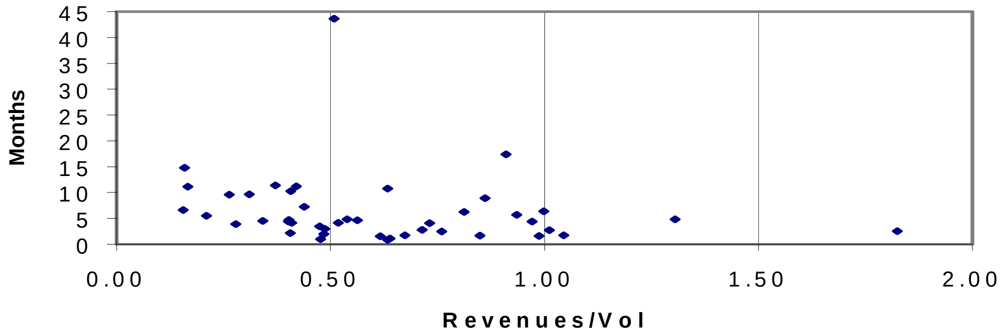


Operational practices are generally inefficient in this sector; poor regular and preventive maintenance procedures allow a high level of water loss through old pipes, which together with the possibility of water theft, amounts to levels of unaccounted-for water at 40-50 percent. A well-managed water service company has a value of 10-20 percent for this measure.

Morosidad

SUNASS selected *"morosidad"* - the ratio of bills not yet collected to the total number of bills expressed, in months - as an indicator of commercial efficiency. Figure 3 shows the relation between this measure and revenues per cubic meter of water produced. We notice in the graph that there is a subtle inverse relation between these two variables. Accounts receivable do not necessarily affect revenues in a noticeable way; however, in this case it seems of big importance and reflects the constrained sustainable situation of these companies. The lower the time wait for bill collection, the higher the level of revenues. Morosidad exceeds six months for 34 percent of the companies.

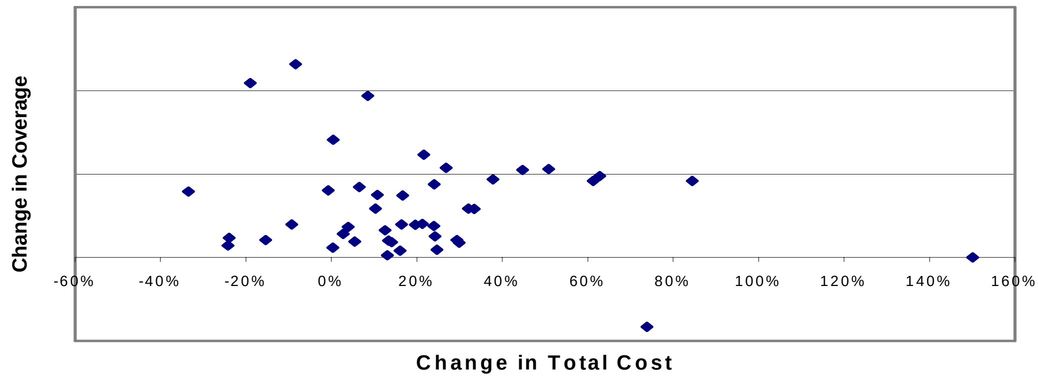
Figure 3: Morosidad vs Unit Revenues



Coverage

Percentage change in coverage will indicate how companies expanded their service during 1996-98. The data indicate that 43 percent of the companies increased their coverage by more than 15 percent. Company 1 had a negative increase despite an increased number of connections. This result is explained by the fact that the increase in population was greater than the increase in number of connections. Figure 4 shows the relation between change in total cost and change in coverage. Notice that, although subtle, there is a tendency for change in total costs to decrease as change in coverage increases.

Figure 4: Change in Total Cost vs Change in Coverage



We observe low levels of unit operating costs and high levels of coverage but this relationship is not strong. However, the pattern may indicate the influence of other factors that can affect cost as coverage increases. For instance, the number of districts administered by each EPS is an interesting variable to consider. It is not related to size or length of the mains. For example, companies 14 (small), 29 (medium) and 37 (big) have four districts each covering a length of 51, 168 and 391 kilometers, respectively. A scatter plot on number of districts and costs or coverage does not show a clear relationship. The bottom line may be the presence of political factors.

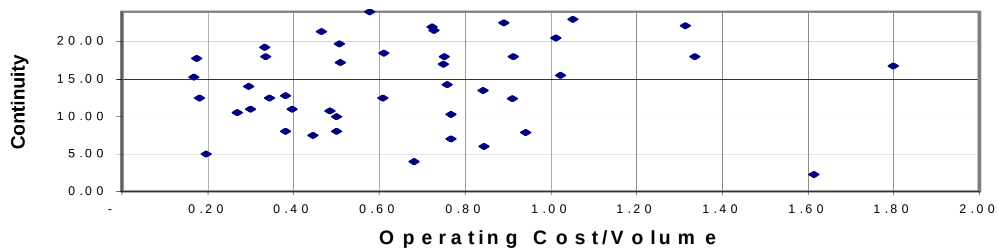
As noted by Tamayo, Barrentes, Conterno and Bustamante (1999), provincial and district mayors decide the makeup of EPS boards. The votes are distributed according to the number of existing connections. Mayors in districts with high coverage have no incentive to expand service within districts with low coverage because their relative power would be reduced. Districts with high coverage may not border each other, and, in fact, the distribution of districts for several EPS involves some distance. Theories of political economy would indicate that when a company expands, it will do so in a high-coverage district. Although we do not have information on coverage per district, we explore the relation between number of districts and operating costs in Section 4.

Quality, Continuity and Coverage

Figure 5 shows the relation between quality and unit cost of sales. Chemicals and other materials needed to ensure water quality are included in this cost. We expect a high unit cost of sale for a high quality level, which is true for a unit cost higher than 0.6. However, when unit cost sales values are less than 60 percent, we find a variety of quality values. We may conclude that there is no consistent indication for quality as a cost driver in this sample for a unit cost lower than 0.6. Although surprising, this result may be explained by the fact that water quality standards in Latin American countries lag behind those of developed countries. Quality standards in these countries usually refer to the minimum value required to guarantee some acceptable level of health to the population. Thus, chemicals, materials and equipment are not sufficiently costly to affect a company's total cost. Figure 6 for continuity and unit-operating cost shows a very similar relationship.

Figure 5: Unit Cost of Sales vs. Quality

Figure 6: Operating Cost/Volume vs. Continuity

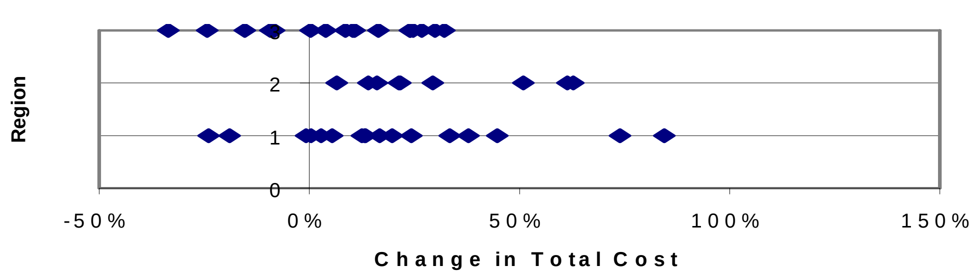


The Effect of Region

Tariffs, unit operating costs, unit salary expenses, administrative expenses and unit revenues are higher in Costa (region 3) and Selva (region 2) than in Sierra (region 1). Salary expenses are higher in region 1.

Quality and continuity do not seem to be affected by region since companies are spread on the range of quality and continuity values independently of region. Change in total cost is presented in Figure 7**.** We observe that a positive increase has been smaller in regions 3 and 2. Regions 3 and 1 have decreasing costs.

Figure 7: Change in Total Cost vs. Region



3. Results from the Analysis

A high level of salary expenses, the result of a high ratio of employees per 1,000 water connections, affects performance of water service companies in Peru. In fact, as Alcazar et al. (2000) mention in their study, the reform undertaken by SEDAPAL at the beginning of 1992 included a reduction of more than 50 percent of its labor force between 1988 and 1996. Labor costs fell sharply and workers per 1,000 connections fell from over 6 to 2. The reduction in labor expenses and a rise in tariffs allowed SEDAPAL to make a profit in 1993 for the first time in more than a decade.

Small and medium-sized EPS have excessive administrative expenses. Two factors help explain the financial difficulties of these companies: a high level of unaccounted-for water, particularly in medium-sized EPS, and a high level of *morosidad*, particularly in small EPS. Big companies have a higher operating margin than the other groups, but this is offset by the fact that profits decrease as number of connections increases. This may reflect poor cost containment and technical management practices.

The drop in number of companies with high administrative expenses with respect to the number with high *unit* administrative expenses and also the drop in number of companies with high salary expenses in relation to those with high *unit* salary expenses show us the big effect that the ratio of water billed and produced has on performance of these companies. A value of 50 percent of water not accounted for in 36 percent of the companies stands for poor operational and managing practices in the sector.

Expansion of service for small and medium-sized EPS has been significant and shows compliance with the main goal of SUNASS. However, the study found no relation between expansion and total costs. The concept of service quality in Latin American countries helps to explain the lack of relation found between costs and service quality factors.

Table 1 summarizes the results of the analysis. Finance indicators are all shown as “bad” (x) and service quality indicators are all shown as “good”(o). Values for EPS that are experiencing losses are highlighted. We observe the diversity of results in each group. How can these indicators help the regulatory agency? Assigning weight and combining these indicators may complement the benchmarking process initiated by SUNASS.

Table 1:Summary of Analysis

COMPANIES	Region	Losses	Unacct. for Water <30	Quality > 80%	Cover inc >20%	Cont >12 hrs	Moro >6 mo.	fin/vol >20%	Adm/ C >40%	Salary >40%	Unit Adm >.40	Unit sal >.40	>6 Empl p/1000	SUNASS Rank
Small EPS														
1. EPS NOR PUNO S.A.	1	x	O	O		O				x	x	x	x	B+
2. EPS EMSAP CHANKA S.A.	1	x	O	O									x	C+
3. EMAPA Y S.R.LTDA.	1						x							C-
4. EMAPAB S.R.LTDA.	2	x		O			x			x			x	B-
5. EMAQ S.R.LTDA.	1		O							x				C-
6.. EMUSAP AMAZONAS	2	x		O				x					x	B+
7. EPS MARAÑON S.R.L.	2	x					x			x			x	D+
8. SEMAPA HUANCAVELICA	1			O					x	x				B-
9. EMAPAU S.R.LTDA.	2	x		O			x	x					x	D+
10. EMAPAT S.R.LTDA.	2		O	O		O					x	x	x	C+
11. EMAPAVIGSSA.	3	x	O				x			x			x	B-
12. EPS SIERRA CENTRAL S.A.	1					O			x	x				C+
13. EMUSAP ABANCAY S.A.	1					O			x	x			x	B-
14. EMAPA PASCO S.A.	1	x		O			x		x	x				C+
15. EMPSSAPAL S.A.	1				O	O			x					B+
16. EPS MOYOBAMBA S.R.LTDA.	2	x		O					x	x	x	x	x	B-
17. EPS MOQUEGUA S.R.LTDA.	3			O		O		x		x				C+

Medium-Sized EPS			Service Quality Factors				Finance Factors								
18. EPS MANTARO S.A.	1						x		x	x				C+
19. EPS SEDA ILO	3	x		O		O	x	x					x	C+
20. EMAPA HUARAL S.A.	3				O	O			x	x				C-
21. SEMAPA BARRANCA S.A.	3	x					x			x				D+
22. EMAPAPISCO S.A.	3	x	O	O		O				x			x	C+
23. EPS CHAVIN S.A.	1	x								x				C-
24. EMAPACOP S.A.	2	x	O						x	x	x	x	x	C-
25. EPS SELVA CENTRAL S.A.	1	x			O	O	x		x	x				C-
26. EMAPA CAÑETE S.A.	3	x		O										B-
27. EMAPA HUACHO S.A.	3	x				O								C-
28. SEDA HUANUCO	1			O		O	x			x			x	B-
29. EMSA PUNO S.A.	1	x	O	O		O		x		x		x		B-
30. SEDACAJ S.A.	1		O		O	O				x		x	x	B-
31. EPS EMAPICA S.A.	3	x							x				x	D+
32. EPS AYACUCHO S.A.	1			O		O				x				C+
33. EPS SEMAPACH S.A.	3					O				x				C-
34. SEDAJULIACA S.A.	1	x	O	O			x	x				x		D+
35. EMAPA SAN MARTIN S.A.	2		O			O				x		x		B-
36. EMFAPATUMBES	3	x		O			x	x						C+
37. SEDA CUSCO S.A.	1		O			O				x		x		C+
Big EPS														
38. EPS LORETO S.A.	2					O								D+
39. EPS TACNA S.A.	3		O	O		O				x		x		B-
40. SEDA CHIMBOTE	3					O							x	B-
41. EPSEL S.A.	3		O	O			x						x	C-
42. SEDALIB	3	x				O	x	x		x		x		C-
43. EPS GRAU S.A.	3					O		x		x		x		C+
44. SEDAPAR S.A.	3	x		O		O				x		x		C+

Even when just a few measures were used, we can see how complex the task of benchmarking is if clear objectives are not established. For instance, company 37 provides continuous service for 18 hours a day and its unaccounted-for water is less than 30 percent; yet, the quality of its water is rated at less than 80 percent. What incentives does this company need? What is the reason for the low level of quality? Company 16 has five bad finance indicators, but its water quality and continuity indicators are good. The company has a negative operating margin. What are the actions that SUNASS should take with this company? Should it be fused with another company or should it just be closed? How to use efficiency values on a benchmarking scheme is the key issue for a regulator.

Combining financial and non-financial measures in this survey of comparative data, gives us a general idea about the performance of these companies. However, other factors that were not detected may be influencing costs. The next section contains a regression model that captures the interactions between other factors affecting operating costs.

4. The Regression Model

The regression model presented follows Cubbin and Tzanidakis (1998) and OFWAT's model for operating cost. Theory of production tells us that outputs y are produced by inputs x, given a technology set P. The boundary of P represents a production function F(y,x) so that P may be defined as

$P = \{ (y,x) / F(y,x) <= 0 \}$.

The origin of disagreements between regulators and utilities may reside in uncontrollable factors outside the definition of outputs and inputs. Expanding the production set to include a firm-specific factor z reflects this issue.

$P = \{ (y,x,z) / F(y,x,z) <= 0 \}$.

In the regulatory context, the cost frontier is of main concern. A cost frontier is the outcome of a minimization process, given the prices p of inputs x. Cost is the product of inputs x and their prices p such that the cost frontier becomes

$C^*(y,p,z) = \min_x \{ px / (y,x,z) \in P \}$.

Following Farrell (1957), cost efficiency can be defined as the ratio of necessary to actual costs,

$K = C^*(y,p,z) / px$ and $0 < K <= 1$,

where px represents actual operating costs for each company. I assume prices constant across the sample so the requirement is to estimate a sub-cost function conditioned on p as

$C^*(y,z/p) = (OperCost)K.$

Since most empirical applications use translog or Cobb-Douglas formulations for the functional form of C*, I use natural logarithm as Cubbin et al. did for their analysis:

$\ln C^*(y,z/p) = \ln(OperCost) + \ln K.$

Expressing ln(OperCost) as a linear function and assuming ln K is normally distributed with mean μ, and independently of the terms containing y and z, then we can use the ordinary least squares regression as the best, linear unbiased estimator of $\ln C^* + \mu$. Thus, the application of OLS would produce an unbiased estimate of the parameters of the cost frontier. Residuals will signify possible efficiencies or inefficiencies, and the observation with the largest negative residual will be considered to be the 100 percent efficient company.

Following OFWAT, the variables used to estimate operating cost are volume of water produced (Volprod) and the length of mains (Length) measured in kilometers. However, unlike OFWAT, we do not know the proportion of water delivered to measured households as opposed to commercial customers. On the basis of the analysis of the data in the last section, I introduce number of districts administered by each company (Loc) to explore its effect on operating costs. I also introduce dummies for region as follows:

RC = 1 if the company is located on the coast, 0 otherwise (region 3 = Costa),

RR = 1 if the company is located in the mountains, 0 otherwise (region 1 = Sierra).

The size of each company is represented in the model by volume produced. The actual operating cost does not include depreciation or provision for uncollectables. Three observations were dropped (companies 2, 4 and 36) since they did not have values for length. The regression equation to be estimated is

$$lnOperCost = \alpha_1 + \alpha_2 RC + \alpha_3 RR + \beta_1 lnVolprod + \beta_2 lnLength + \beta_3 lnLoc.$$

The intercept captures the effect of region 2 (Selva). Based on the regression of squared residuals on squared fitted values and all cross-terms, the null hypothesis of homoscedasticity was accepted. Estimation of the regression equation produced the following result, with t-ratios in parentheses:

$$\underset{}{lnOperCost} = \underset{(1.76)}{2.496} \underset{(-0.912)}{- 0.170RC} \underset{(-2.360)}{- 0.408RR} \underset{(5.717)}{+ 0.632lnVolprod} \underset{(5.937)}{+ 0.609lnLength} \underset{(-1.961)}{- 0.214lnLoc}$$

The above model suggests that the main operating cost drivers in Peru's water sector are volume of water delivered, the length of mains, the number of districts administered by a company and the region where the company is located. These factors explain more than 90 percent of the variation in cost. Cost savings are associated with a greater number of districts served and location in region 1 (Sierra).

Number of districts and region 2 (Selva) are statistically significant at the 10 percent level, region 1 (Sierra) at 5 percent and volume produced and length at 1 percent. The coefficient on region 3 (Costa) is not statistically significant. The model appears to be of a good fit with R^2 adjusted = 0.908 and a standard error of the estimate = 0.4015.

The resulting signs are very informative. Cost savings from region 1 (Sierra) may be explained by the source of water. Waterworks that draw water from rivers differ in costs from works that draw from groundwater. The sum of the coefficients of volume and length with a value of 1.241 reflects scale economies. To better explore a surprising result (why number of districts was statistically significant), alternative models were estimated. These differed mainly in how the number of districts is treated --as a dummy (representing 1, 2-4, or more than 5 districts) or a logarithm variable.
There was an increase in statistical significance when introducing the dummy instead of the logarithm form. When number of districts is equal to 1 (model 5), the coefficient is positive and not statistically significant. When number of districts is between 2 and 4, the coefficient is found to be negative, but not statistically significant. Finally when number of districts is greater than or equal to 5, the coefficient is negative and statistically significant at the 5 percent level of confidence in all models. Thus, we may conclude that there are cost savings associated with number of districts greater than or equal to 5.

We could infer that a possible explanation for this result is the presence of economies of scope (in terms of distinct geographic or political areas served by an EPS). Another possible source of economies stems from political factors that might raise costs when only a few districts are served, but promote efficiency with more districts. Under current voting rules, water companies may choose to expand service to districts with high levels of coverage because of political support from the board of directors. As number of districts increase, there may be a reduced role for political influence and favors in terms of inefficient practices in employee hiring. Such a decline in costly activities may contribute to observed cost savings for multi-district EPS.

An important implication obtained from the model specification is the effect of mergers on operating costs. Consider the initial specification of the model and rewrite it as

$OperCosts=(Constant)(Volprod^{\alpha})(Length^{\beta})(Loc^{\gamma})$.

If a merger occurs between two equally situated companies, we obtain the following:

$Joint\ OperCosts = (Constant)(2Volprod)^{\alpha}\ (2Length)^{\beta}\ (2Loc)^{\gamma}$;

$Joint\ OperCosts = 2^{\alpha+\beta+\gamma}\ (OperCosts)$.

Utilizing the specific coefficients from the basic model (2) estimation, we have:

$\alpha+\beta+\gamma = 0.632 + 0.609 - 0.214 = 1.027 \approx 1$.

Thus, Joint OperCosts = 2 (OperCosts). This result suggests that when two water companies of equal size merge, the operating costs of the new company will be roughly equal to the sum of the initial operating costs of the merged companies. Of course, this specification does not include the nonlinear effects that would be obtained if two firms with three districts joined together, which would reduce the political interference that appears to cause higher costs when only a few districts are serviced by the ESP. Increasing number of districts and, in consequence, the mergers among companies that result in a joint company with more than five districts appear to be a source of significant cost savings generally.

Companies with positive residuals have below-average efficiency while companies with negative residuals have above-average efficiency. The levels of efficiency shown in Table 2 are ranked from most efficient (top row) to least efficient and are calculated as follows:

$$\text{Level of efficiency} = \frac{\text{Actual Operating Cost - Predicted Operating Cost}}{\text{Predicted Operating Cost}}$$

Another interesting result is shown in Figure 8. As revenues increases, efficiency tends to decrease. An explanation of this may be that cost containment receives less attention as revenues increase. Management may feel less pressure as they see revenues increase, so operating cost are not minimized. Under a competitive environment we would expect to see efficient companies with positive profits and inefficient ones with financial losses. This figure provides evidence for lack of incentives for efficiency within the companies.

Figure 8: Profits vs. Efficiency

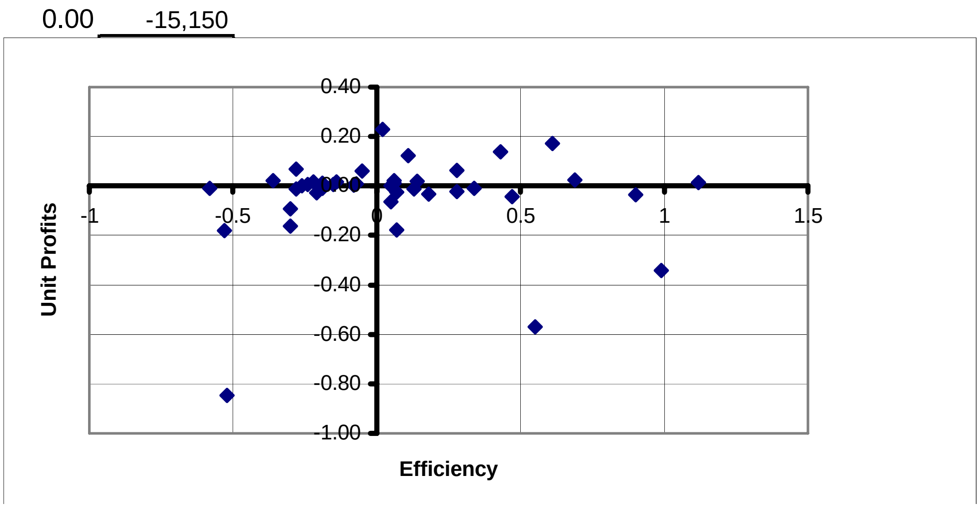


Table 2: EPS by Level of Efficiency

Rank	Level of Efficiency	Company	Region	Company Name
1	-0.58	14	1	EMAPA PASCO S.A.
2	-0.53	9	2	EMAPAU S.R.LTDA.
3	-0.52	34	1	SEDAJULIACA S.A.
4	-0.36	3	1	EMAPA Y S.R.LTDA.
5	-0.30	22	3	EMAPAPISCO S.A.
6	-0.30	31	3	EPS EMAPICA S.A.
7	-0.28	23	1	EPS CHAVIN S.A.
8	-0.28	33	3	EPS SEMAPACH S.A.
9	-0.26	25	1	EPS SELVA CENTRAL S.A.
10	-0.24	40	3	SEDA CHIMBOTE
11	-0.21	21	3	SEMAPA BARRANCA S.A.
12	-0.19	7	2	EPS MARAÑON S.R.L.
13	-0.19	15	1	EMPSSAPAL S.A.
14	-0.15	32	1	EPS AYACUCHO S.A.
15	-0.14	41	3	EPSEL S.A.
16	-0.08	28	1	SEDA HUANUCO
17	-0.07	8	1	SEMAPA HUANCAVELICA
18	-0.05	17	3	EPS MOQUEGUA S.R.LTDA.
19	-0.02	20	3	EMAPA HUARAL S.A.
20	0.02	38	2	EPS LORETO S.A.
21	0.05	13	1	EMUSAP ABANCAY S.A.

22	0.05	24	2	EMAPACOP S.A.
23	0.06	12	1	EPS SIERRA CENTRAL S.A.
24	0.06	35	2	EMAPA SAN MARTIN S.A.
25	0.07	16	2	EPS MOYOBAMBA S.R.LTDA.
26	0.07	44	3	SEDAPAR S.A.
27	0.11	39	3	EPS TACNA S.A.
28	0.13	26	3	EMAPA CAÑETE S.A.
29	0.14	18	1	EPS MANTARO S.A.
30	0.18	42	3	SEDALIB
31	0.28	11	3	EMAPAVIGSSA.
32	0.28	43	3	EPS GRAU S.A.
33	0.34	6	2	EMUSAP AMAZONAS
34	0.43	37	1	SEDA CUSCO S.A.
35	0.47	27	3	EMAPA HUACHO S.A.
36	0.55	19	3	EPS SEDA ILO
37	0.61	10	2	EMAPAT S.R.LTDA.
38	0.69	5	1	EMAQ S.R.LTDA.
39	0.90	1	1	EPS NOR PUNO S.A.
40	0.99	29	1	EMSA PUNO S.A.
41	1.12	30	1	SEDACAJ S.A.

5. Concluding Remarks

The heterogeneity of the water service companies in Peru presents a major difficulty for the regulator in establishing levels of performance. The introduction of a benchmarking scheme has been a first step for SUNASS, given its limited regulatory instruments. Understanding the differences between companies and groups of companies will promote the use of efficiency measures. However, much work still needs to be done. Clearly, the agency needs to place greater emphasis on service quality factors and refinement of finance indicators. In a country with national water coverage at 69 percent, it is difficult to obtain a political consensus on sector. Quality of water lacks importance to a customer with continuous service of less than five or six hours daily. Additionally, the lack of appropriate comparative data about quality, prices, quantity and service coverage has made it hard for customers to exert pressure on the water companies. Publication of benchmarking results by SUNASS is a good start and may help customers and other stakeholders become more informed about the poor performance relative to others—leading to pressures for reform and industry restructuring.

The use of a regression model for operating costs allowed us to establish a cost frontier. Companies were ranked according to their efficiency levels. Efficiency represents the deviation of each company's actual operating cost from the average. Average operating cost was estimated by considering the effects of region, the volume of water produced, length of mains and the number of districts administered by each company. The effect of number of districts is interrelated with political factors. Cost savings from number of districts may be associated with the presence of "political non-interference" economies rather than with scope economies. The effect of this variable warrants additional attention.

The results from efficiency vs. unit profits within the EPS are clear. No relation was found between efficiency and profitability (measured by operating margin). This may imply a lack of incentives for attaining efficiency within the companies, which may reflect the absence of regulatory instruments for rewarding or penalizing the firms.

Rules constrain utility decision-makers only when enforcement mechanisms exist. Any kind of regulation or government intervention creates incentives. However, if the agency cannot reward excellent performance, technically sophisticated studies and planning documents mean nothing unless they can be translated into improvements in sector performance. At present, SUNASS can collect “master plans” and announce quality standards, but this has little impact if municipal managers face no consequences for poor performance.

If the law is ambiguous or does not give appropriate tools to agencies responsible for the oversight of the water sector, then the law should be revised by targeting the sources of current inefficiencies.

Nevertheless, SUNASS is to be commended for publicizing the efficiency measures presented in Tables 1 and table 2. However, the impact of continued data collection and benchmarking requires a clear set of financial and quality service objectives. The regulatory agency has taken some initial steps. Now it is time for other stakeholders to support reform initiatives that can promote better performance across firms in this important infrastructure sector.

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