BENCHMARKING CENTRAL AMERICAN WATER UTILITIES

Executive Summary (Inter-American Development Bank RS-T1271)

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Key Lessons from Practitioners

Participants in the recent Benchmarking Workshop (San Jose, Costa Rica, October 15-16) identified factors having an impact on data quality, data collection, benchmarking methodologies, and possible policy and regulatory implications of performance rankings:

1. The person (and the company) responsible for the data (collection, verification, storage, and processing) must be convinced about the importance of his (or her) role. Besides serving as a report to the regulator or to any external institution, data must be viewed as important and useful for the company – for strategic, operational, administrative and commercial purposes.
2. Duplication of data storage files inside the firm and data reports (in specialized formats) to external institutions must be avoided or reduced. Duplication raises administrative costs and opens up the possibility for little "Information Empires" where individuals exercise power by withholding data from those who should have access to information.
3. There needs to be a person responsible for data within the company; however, it is the position (rather than the person) that must have continuity over time within the company. This formalized role is needed to address internal turnover problems which limit data collection, causing gaps in time series and in cross-section observations.
4. Clear variable definitions allow outsiders to interpret information; consistency and clarity are fundamental to the management process.
5. Factors external to the company may have an impact on the collection and storage of data. For example, the existence of records and maps of the city; the frequency of the country census; municipal or city restrictions regarding the network design; number of connections per km, and type of users of the network.
6. Data disaggregation improves decision-making. Clear customer classification (residential, industrial, and commercial) allows for more accurate information regarding operation and performance of the company. In addition, maintaining data series on particular regions or divisions of a company allows top managers to develop strategies for rewarding strong performance. Disaggregated data allow managers to target areas of sub-standard performance and facilitates quantitative studies of cost and productivity.
7. Better operational data collection procedures are needed: timely reports that identify patterns mean that network repairs can be addressed in a comprehensive and cost-effective manner.
8. Information technology is necessary, but not sufficient, for sound management: information systems should link financial-commercial-operational data. Leaders can only manage what they measure.
9. The company information needs to be public to promote managerial accountability and citizen confidence in infrastructure services. Even rough comparisons can put pressure on political leaders to fulfill promises to provide funds for network expansion and on managers to deliver services at least-cost.
10. Overall, there is a need within the firm for more information regarding benchmarking methodologies and their application. Larger water utilities have engineers who are familiar with process benchmarking. There is also a need for capacity building in the area of metric benchmarking—starting with trends in Core Indicators, and moving to basic statistical reports and DEA studies.

Introduction to the PURC/IADB Benchmarking Project

A recent IADB study reports that investments of $40 billion for water assets are needed to meet the United Nation's Millennium Development Goals; wastewater treatment would significantly raise that funding requirement[1]. A survey of 400 stakeholders included in the study identified inappropriate pricing policy and lack of clarity in regulatory processes as the two major constraints for increasing investment in water and sanitation systems (WSS) in Latin America and the Caribbean. Private sector funding could play a role in expanding or improving urban water systems through either equity investments or the purchase of municipal bonds. However, external financial flows are required to increase significantly absent major improvements in system performance and to develop incentives for better WSS performance – in the sense of increased quality of service provision and cost efficiency of the utility system's operation[2].

Expecting infrastructure investment to grow in Centro America, the Inter-American Development Bank (IADB) funded a PURC study on *Benchmarking Water Utilities* in the region. Resource allocation issues associated with infrastructure industries are important for Central American countries. The aim of IADB was to gauge the impact of loans on network expansion (coverage) and on service quality. In addition, water professionals at international organizations must be able to understand what utilities (and nations) are doing as "best practice" so that incentives can be developed to enhance performance. The project involved conducting metric benchmarking analysis using data gathered from national regulators and utilities. This work complements and extends the Association of Water Regulators of the Americas' (ADERASA) recent empirical study on benchmarking Latin American water service providers.

It is important to note that the empirical results are the first to be obtained for utilities in the region. Thus, these performance comparisons should be taken as the first steps towards making robust comparisons. Data limitations affect model specification: not all elements affecting cost (such as dimensions of service quality) are in the model. Furthermore, the fact that some firms have supplied data indicates that they are at least collecting data now—suggesting that these utilities are likely out-performing those utilities whose managerial teams have no historical records of core indicators and no interest in being compared to other managers. Non-participants in this may fear greater transparency since that would alert citizens to utility shortcomings. Without a census of utilities, this sample is subject to self-selection bias: these are likely to be the high performing utilities in the region. This is not a problem for frontier analysis, but this means that very weak firms are unlikely to have volunteered to participate in this benchmarking initiative.

1. The Role of Benchmarking in Developing and Implementing Water Policy

Benchmarking represents an important tool for those developing and implementing water policy. Developments over the past decade in quantitative techniques and pressures for sector reform have stimulated interest in identifying and understanding the factors that can contribute to WSS network expansion, improved service quality, and cost containment. An empirical study of water institutions identified four policy elements that explain sector performance: the economic orientation of project selection criteria, level of cost recovery, policy reform linkages, and water law and water policy linkages. Benchmarking is crucial for several of these elements[3]. Policymakers in Latin America, Asia, and Africa have begun to collect data that can serve as the basis for performance comparisons—creating yardsticks that help decision-makers identify weak and strong performers. Utility managers, water associations, regulators, and other groups have begun to undertake statistical analyses of water systems—over time, across geographic regions, and across countries.

Empirical procedures allow analysts to measure cost or productivity performance and identify performance gaps. Such metric benchmarking tools are important to:

- Document past performance,
- Establish baselines for gauging productivity improvements, and
- Make comparisons across service providers.

Rankings can inform policymakers, those providing investment funds (multilateral organizations and private investors), and customers regarding the cost effectiveness of different water utilities. Robust performance comparisons require analysts to obtain comparable data across firms, select appropriate empirical methodologies, and check for consistency across different methodologies.

While benchmarking is not a panacea for overcoming the impediments for investment, it does provide key inputs into public policy debates and managerial evaluations, with wide-ranging implications for the following:

- Sustainability of capital inflows, public deficits, and reform initiatives. Typically, investors seek government guarantees, but guarantees can blunt incentives to select efficient projects. In addition, guarantees can become liabilities affecting government budgets[4]
- Poverty reduction and public perceptions regarding infrastructure reforms;[5]
- Development and implementation of incentives for improving WSS service performance;[6]
- Appropriate roles for multinational organizations, donor nations, and regional cooperation in the provision of WSS services.

2. The PURC/IADB Benchmarking Project

The purposes of this Central America Benchmarking Project are threefold:

1. Assemble verifiable benchmarking data for the Central American nations;
2. Prepare studies that identify the relative performance of utilities in the region;
3. Design and deliver a workshop to promote sustainable data collection procedures, making information available to key stakeholders.

The first objective required the cooperation of government agencies in the region, as well as water utilities. Until recently, data specification, collection, and collation have been the focus of benchmarking programs.[6] Once the analyst has several years of consistent data available for an adequate sample of utilities, the issue becomes one of analysis, including model selection. A substantial body of technical literature exists. The PURC *Survey of Benchmarking Methodologies* (a project funded by the World Bank) aimed at helping practitioners begin comprehensive analyses on the subject[7]. The bottom line is that without data, managers cannot manage and analysts cannot analyze.

The regional workshop was designed to have participation from four groups: utility managers, policy-makers, regulators and academics. These groups have tended to operate in relative isolation when preparing benchmarking studies. The objective of the Workshop besides providing a forum for obtaining feedback on the study is to promote sustainable institutional mechanisms for maintaining data collection, and to develop strategies for future regional collaboration. For example, IB-Net serves as a data repository for hundreds of water utilities from around the world. Similarly, the ADERASA Benchmarking Task Force has recently completed a quantitative analysis of participating countries. Participants who were involved in data collection will serve on panels to comment on the strengths and weakness of current data procedures. The workshop will be a catalyst for improving procedures for evaluating sector performance.

3. Main Data Collection Issues

This study includes data obtained and/or reviewed by water service providers from each of the six countries under consideration in addition to the participation of the respective country regulatory agency. This approach differs from studies performed by ADERASA, which mainly considers data provided by regulatory agencies. In addition, this study includes Guatemala and El Salvador which are not members of ADERASA. The data collection process was undertaken in two steps: accessing regulatory agencies and then contacting water service providers. In all cases, regulatory agencies were made aware of our direct contact to water service providers to follow the information links that exist between the regulatory agency and the utility.

Overall, factors that affect data availability within this region are several:

- On-going water sector restructuring (from an institutional point of view);
- Low level of water infrastructure in place; and
- Low development of the sector’s information technology (affecting data collection and record-keeping.

The first factor is illustrated by the decentralization process, as in the case of Honduras, where service responsibility has devolved to municipalities. Institutional reform is seldom a simple process, with data collection sometimes suffering. In addition, scale economies in information provision can be lost through such initiatives.

In terms of network coverage, El Salvador, Honduras and Nicaragua show a low level of infrastructure in place. In addition, the number of local and independent water providers (such as juntas vecinales de agua) complicate the data collection/correction process[8].

Finally, the development of information technology is central to any data collection initiative. According to United Nations agencies' statistics on measuring Information and Communication Technologies[9], the diffusion index (ICT) for these countries - from high to low - is approximately 40% for Costa Rica; 30% for Guatemala; 25% for Panama and Honduras and 15% for El Salvador and Nicaragua . Information technology is central to any structured data collection procedure. The availability of an information system specific for the sector is crucial for any data collection process within the region.

However, the supply of technology is necessary but not sufficient for improved information on water utility performance. Besides utility managers who are the main responsible for collecting appropriate data for running their businesses, the role of other stakeholders (citizens, public officials) should be considered by government when developing rules regarding the sector. For example, it is essential that regulatory agencies are allowed by law to collect data from utilities. In the same way it is important the establishment of formal communication channels among all the institutions related to the sector, such as environmental or municipal development agencies so that responsibilities for data collection and possible data repositories are well identified.

4. Summary of the Project

The Final Report provides overviews of the water sectors for Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. Because data from all service providers are not available for this study, knowing the proportion of population that is served by each utility with respect to total country population allows us to identify the comprehensiveness of this study besides identifying directions for future data collection. The analysis finds evidence of substantial fragmentation of service provision in some countries, which may raise the cost of data collection.

After describing the data collection procedures, the study examines performance patterns across countries. Some of these performance indicators are compared to those presented by the ADERASA benchmarking group in its most recent annual report for Latin America. After reviewing trends for 2002-2005, Total Factor Productivity (TFP) indices are calculated for water utilities in each country for 2005. This approach considers the mix of inputs used to produce the mix of outputs. TFP indices provide a more comprehensive performance assessment compared to core performance indicators (simple ratios like output per worker or connections per worker). Nevertheless, many factors can affect these specific performance indicators, including population density, ability to pay (income levels), topography, and distance from bulk water sources.

The relationship among factors is also of important consideration. A firm that performs well on one indicator may do poorly on another, while one company doing reasonably well on all measures may not be viewed as the "most efficient" company. Thus, the focus of this project moves beyond simple performance indicators to a more comprehensive performance metrics using DEA frontier calculations and stochastic estimation to provide insight into the relative performance of water utilities in the region under a varied set of methodologies. This project establishes a strong case for more comprehensive studies in the future.

5. Core Performance Indicators and Trends

These performance indicators are very simple but provide a picture of the performance characteristics of the Central American water sector. Some of these performance indicators are compared to those presented by the ADERASA benchmarking group in its most recent *Annual Report for Latin America*. To maintain consistency, definitions of these indicators are the same as those developed by ADERASA. Comparisons using these core performance indicators provide a first step in evaluating relative performance.

Water service provision can be measured by three factors: volume of water, number of connections and population served. Based on these dimensions, two groups of utilities are identified for the Central American countries: *large utilities*, comprised of IDAAN, AYA, ANDA and ENACAL and the *small utilities* group which includes SANAA, ESPH, Aguas de Puerto Cortes, and EMAPET. The following is a summary of results from calculating the selected performing indicators:

Operational indicators

Water lost (or commercial efficiency): This performance indicator reflects deficiencies in either operational or commercial practices. The extent of water losses may reflect a cost tradeoff between increasing water production and repairing network leaks to keep up with water demand. Managers may find it more costly to repair leaks and to control water losses than increase water production to satisfy demand. It is plausible to argue that given the characteristics of this sector it may be hard for firms to control commercial losses if that entails denying the service to the poorest segments of the population. Overall, for the Central American data set, volume of water lost averages **41%**.

Another way of viewing this indicator is to calculate the ratio of water billed to water delivered which is referred by the ADERASA benchmarking group as an indicator for commercial efficiency. The Central American median value for this indicator is **60%** which is higher than the 40% value obtained by ADERASA members.

Metering: This element is calculated as the ratio of the number of connections with a meter in place to number of total connections. Meter installation costs are high and in some countries it is a direct allocation of costs to the consumer, which may translate into higher tariffs. Overall, metering median value is **55%**, which is lower than the 75% median value for ADERASA members.

Service coverage: This operational performance indicator is calculated as the ratio of population with water service to total population in the area. Water service coverage for the Central American countries is **90%** very close to the ADERASA value of 89% for Latin America. There is a noticeable coverage gap between large and small utilities. Coverage is equal to 93% for large firms and 78% for the small water utilities.

Network density: This indicator is defined as the ratio of number of connections to network length. It equals 86 on average for Central American countries. Larger firms have denser networks than smaller firms.

Water consumption: The ADERASA benchmarking group utilizes the ratio of volume of water billed to population with water service as an indicator for water consumption. The median consumption value for the region equals **219 liters per person per day**, which is slightly higher than the ADERASA value of 172. Smaller companies are able to satisfy a higher consumption level - 323 liters per person per day- as opposed to a lower 222 satisfied by the larger firms.

Number of workers per one thousand connections: This indicator is used in the water sector literature as signaling labor efficiencies or inefficiencies. The median value for this indicator equals **6.7**, which is twice the value for ADERASA members suggesting labor inefficiencies for this region compared with the Latin America region.

Cost indicators

Operating costs include labor and energy costs, chemicals, administrative and sales expenses. Depreciation and finance expenses are considered as part of total costs. On average, operating costs are $**86/connection**. As network density increases, operating costs per connection decreases for large firms whereas small companies show a direct relationship for operating cost and network density.

The median operating cost per cubic meter of water for the Central America countries is $**0.10/m3**, half the cost of ADERASA member countries. Regarding the proportion of each element comprising operating costs of each firm, for the large group, the median administrative expense per connection equals $27 whereas it equals $34 for the small group. Both values are lower than the similar indicator for ADERASA members ($47).

Quality indicators

> For the quality indicator compliance with water quality standards the Central America countries display a median value equal to **97.53%,** slightly higher than the 95.96% value for ADERASA members. Continuity - the number of hours with water service - ranges from 20 to 24 hours. Number of complaints per connection (median value) is similar for both ADERASA and Central American utilities. The median number of leaks per km of pipe is 2.53 for ADERASA members, almost half the value found on Central America countries, 5.19.

System expansion and cost trends 2002/2005

Changes occurring in number of connections and network length imply system expansion, so utilities can be at different stages of the investment cycle within the region. As a result of system infrastructure expansion, water delivered and population served may increase. Main findings particular for each company are the following: **s**ystem expansion where all variables have been proportionally increased, system expansion with reduced water consumption, and increase in network length greater than the increase on number of connections.

Overall, operating costs changes are small. Costa Rica-AYA displays a significant increase in cost of workers and administrative expenses, which may explain the increase in its operating costs. On the other hand, IDAAN increase in operating costs may be explained by an increase in energy costs. ANDA displays diminishing administrative expenses which may explain the decrease in its operating costs.

6. Total Factor Productivity Analysis

This study assesses firms' productivity by means of Total Factor Productivity indices (TFP) calculated for the period 2002-2005. This is a more comprehensive assessment of performance compared with the core performance indicators (simple ratios) described earlier. The basic idea behind a TFP index is to know how much output is produced due to each unit of input. In practice, there may be more than one output which is produced from a combination of inputs so the TFP index is constructed as the ratio of an output index to an input index, in such a case it captures the input mix that produces the output mix. Each index reflects the relative importance of its elements by using weights. Three aspects are relevant when setting the above mentioned weights for calculating a TFP index: the selection of *the elements* that represent the weights, the mathematical or *functional form* that combines them, and whether or not the weights are *the same* for the two analyzed periods. These alternatives produce different methods for calculating TFP indexes.

Considering the initial set of prices (base period) it yields a ***Laspeyres*** index while using the final period prices produces a ***Paasche*** index. However, the most common used index is the ***Fisher*** index which uses the geometric mean of the two periods. The three indexes defined so far imply a linear form. The ***Tornqvis*****t** index uses a logarithm form which from a theory point of view implies higher flexibility and can reflect actual production technologies.

Two sets of TFP measures are calculated for the Central America water service firms, one considering *volume of water billed* as the output and another considering *number of connections*. This simplifies the analysis by not requiring weights for the outputs. *Labor and energy volume* are the input factors considered on both measures. Input factors weights are calculated as the ratio of their respective costs relative to direct operating costs.

The calculation of TFP index produces similar results using either the Laspeyeres, Paasche or Fisher methods which may be explained by the fact that weight magnitude's variation between the first and last period are very small. A value higher than one means increased productivity whereas a value smaller than one indicates that productivity has decreased by one minus the value of the index. IDAAN is the only company displaying increased productivity with respect to both number of connections and volume of water, when considering labor and energy as the only input factors of the production activity. Its productivity increase ranges from 15% to 42% depending on the output under consideration and the selected TFP methodology. For all indexes, calculations using volume of water billed and numbers of connections differ in that they flip the ranking of the second and third service providers. This may suggests that ANDA is more productive from a connections point of view and ENACAL from a volume of water point of view.

7. **<u>Data Envelopment Analysis</u>**

To address relative technical efficiency for the group of firms, we calculate a technical frontier for year 2005 using Data Envelopment Analysis. This methodology is viewed as an "extreme point" method because it compares production of each firm with the "best" producers. The main assumption is that if firm A is capable of producing, for example, 100 units of output with 12 units of inputs, then other firms should also be able to do the same if they were to operate efficiently. Efficiency results from a DEA frontier are contingent to three main factors:

1. The composition (homogeneity) of the sample to be analyzed - it determines the set of best producers to be compared to each firm
2. The set of selected inputs and outputs which establishes the comparison terms
3. The quality of the data on the sample (presence of errors or noise)

The output of a DEA calculation is the proportion by which the observed inputs could be contracted if the firm where efficient. This input approach intuitively means that same level of output can be produced optimally with fewer inputs (utilities most generally have service obligations to all customers under a pre-fixed tariff, so firms' choice is on input rather than output quantities). As with the other methodologies, comparisons exclude a number of factors affecting production conditions (hydrology, population geography, topology, service quality levels, and other elements affecting the production technology).

Two groups of firms according to size were identified which leads to investigating the impact of firms' scale on the efficiency measure by calculating the DEA frontier using constant returns to scale and variable returns to scale.

Even when service providers' inefficiency may be due to their production practices per se, inefficiency can be affected by these firms being favored (or un-favored) by country specific circumstances. Gross National Income (GNI) per capita[10] is the variable chosen to capture the impact of each country characteristics playing an additional input resource role on calculating the efficient frontier.

Volume of energy was used as an input factor to calculate TFP indexes however not all companies reported this input. Length of the network is considered as an input instead so the frontier approach can utilize all firms from the Centro America sample. Two scenarios (or economic model specifications) are presented, each with the variation of including or not the country specific GNI.

1. Model 1 considers number of total workers and network length as inputs, and volume of water billed, number of connections and population served as outputs.
2. Model 2 considers only labor as the input factor and network density instead of number of connections is included together with volume of water billed and population served as the set of outputs.

The sensitivity of the results to the inclusion of the GNI variable suggests that this country characteristic does have an explanatory role on these firms' production process. In other words, the firm's production process is affected by its country of location. In addition, efficiency values are lower (higher inefficiency) for the model which considers network density as an output (model 2) as opposed to the one using number of connections (model 1). This variation suggests that network density captures additional inefficiency factors affecting the production processes of these firms related to the size of the network relative to the number of connections.

Results indicate that for the group of large firms, IDAAN, ANDA and ENACAL are 100% efficient. AYA is more efficient when considering network density as an output, and it is also more efficient if considering its size (Variable returns to scale). For the group of small firms, ESPH and Aguas de Pto Cortes are 100% efficient. SANAA and EMAPET have very similar results.

Besides level of efficiency and the peer group composition, the DEA frontier calculation produces efficient input and output targets for inefficient firms, which correspond to decreases in inputs and increases in outputs with respect to the level of inputs and outputs of the peer group. In some cases, the decrease in inputs is not enough to bring a company to the frontier so an increase in outputs is also necessary. In this sense, this benchmarking approach provides very specific measures to be taken on account with regards to inputs and outputs.

8. Technical Efficiency Change

A Malmquist index measures the Total Factor Productivity change between either two time periods or two firms by utilizing the ratio of the distances of each data point relative to a common production technology. From the Malmquist index it is possible to calculate a measure of input-oriented technical efficiency change for the analyzed period (the catching up effect or movement towards the frontier). It is important to notice that while a TFP index is calculated only on reference to a particular firm – a firm change of productivity over time – the efficiency change component of the Malmquist index is calculated with respect to the movement of a firm towards the optimal frontier determined by a group of firms. When calculating this index it is common practice to utilize DEA to calculate these distances.

Overall, there are not significant changes on efficiency, which can be explained by the short period considered (only 4 years) in addition of the type of industry. Results points out **IDAAN** with around 10% increased inefficiency and **AYA** with around 4% increased efficiency. Other firms do not show efficiency changes using this approach.

9. Stochastic Cost Frontier

So far, inputs and outputs have been considered in calculations using non-deterministic approaches that examine efficiency and productivity from a production technology point of view. This section develops a very general picture regarding cost efficiency by considering cost behavior according to the choice of input prices, given a level of output produced. A stochastic cost frontier is estimated to analyze cost efficiency among firms. This methodology takes into account a functional form for the production technology that recognizes the relationship among factors entering the production process; furthermore, it recognizes that there may be errors and noise within the data reported distinguishing them from inefficiency by yielding a frontier.

The ideal framework would be to completely specify a cost function including outputs, input prices and those specific factors capturing possible cost differences among firms and countries. Data limitations restricted this ideal specification to the simplest functional form and to the inclusion of only four variables: volume of water billed, price of labor, price of energy, and GNI. In this model, GNI is considered as capturing possible technological differences for each firm according to its country of location. Time is included in the estimation of the panel frontier to explain possible efficiency changes over time. The resulting cost efficiency levels permit the ranking of firms. Given the limitations of the model, these rankings must be interpreted with great care and should include the consideration of unique firm-specific production circumstances.

Results indicate that as GNI per connection increases by 1%; the effect on unit costs is to decrease them by approximately 0.3%. An increase of 1% on volume of water per connection yields an increase in unit costs of approximately 0.5%. An increase in price per worker per connection of 1% produces an increase in unit costs of approximately

0.2%. The coefficient estimate for energy price indicates that a 1% increase in this variable produces approximately 0.14% increase on costs.

Increasing volume has less than proportional increase effect on costs, indicating the presence of economies of scale. The statistical significant coefficient for the relevant parameter of the model implies that inefficiency has changed over time following an exponential path. Inefficiency for those firms with four years of data has increased by 0.1% ; it has increased by 0.06% for those water utilities with three years of data. Table 18 shows firm ranks according to how far is each firm from the frontier and possible reduction of operating costs by 2005 calculated as the ratio of the estimated inefficiency value to actual operating costs.

As it has been previously explained, there are differences between results from the DEA frontier and the estimated cost efficiencies that can be explained by the fact that when calculating the DEA frontier we were looking at a contraction of inputs for a given level of output. A cost frontier looks at minimizing costs given input prices and output on theoretical grounds. When assuming the minimum set of inputs for a given level of output we abstract from other aspects influencing the production process such as the price of inputs. Additionally, the DEA approach considers efficiency with respect to the best performers, given the variables selected whereas the estimated cost frontier is a measure of central tendency considering all firms not just those on the frontier.

10. Concluding Observations

The analyzed framework indicates that the data utilized in this study is fairly comprehensive, except for some countries. The quality of the data set utilized is considered good in the sense that it has been reviewed by its owners. The expectation after the workshop is for additional data rather than for data corrections. A major conclusion from this analysis points towards additional efforts to improve data collection. A higher level of coordination is needed if data are to be collected and trends analyzed. By identifying segments of the industry with no data, policy-makers, regulators and managerial staff are encouraged to introduce additional efforts to seek disaggregated data to facilitate quantitative analysis which will provide more complete information regarding sector performance.

Turning to some features of the analysis performed here, a low metering indicator – 55%- suggests the need for attention from policy makers. Water service coverage for large companies is above 90%, however small companies lagged behind with a 78% value for coverage. In addition, the network density indicators point towards small firms having less dense networks than large firms. This signals possible costs problems for small companies when it comes to serving densely populated areas. Greater labor inefficiencies were found in this region compared to other Latin America countries. The identified gap among firm's cost of workers can be explained by the different composition of the workers group (managerial versus operational employees) in addition to the usual country specific differences in the cost of labor. The median number of leaks per km of pipe for the Central America countries is double the value for this indicator for Latin American countries. The natural relationship between administrative expenses and number of leaks indicates that a more detailed analysis is needed regarding these expenses for this sector.

This study is comprehensive, ranging from the examination of the water sector structure characteristics of each country within the region to particular firm performance behavior under very specific scenarios. Hopefully, the information obtained as a result from this analysis may be seen by the participating firms as a new way to look at their production processes and performance. For regulatory agencies, related government institutions and funding agencies, this study may contain additional information for their strategic planning and decision making processes.

This study should be viewed as a first step in the analysis of water utilities in Central America. As data from additional years become available and more utilities provide information, analysts will be able to conduct much more thorough analyses of sector performance. Hopefully, the present results will serve as a catalyst for more comprehensive data collection/verification initiatives in the region and for additional quantitative studies. Certainly, if national and regional development banks and international donor organizations are to targets opportunities for improving sector performance, they need to have reliable information on trends and on best practice. If they are going to identify the impacts of new funding, they need to have baselines. It is in the interest of all the stakeholders to devote more resources to the systematic collection and analysis of water utility financial and operational information.

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[1] "Obstacles and Constraints for Increasing Investment in the Water and Sanitation Sector in Latin America and the Caribbean: Survey," IADB, Dec 2003, 1-13.

[2] See Peter Reina (2002), "Latin Lessons for the Private Sector," *Water21*, April, 19-21.

[3] R. Maria Saleth and Ariel Dinar (1999), *Evaluating Water Institutions and Water Sector Performance,* World Bank Technical Paper No. 447.

[4] For an overview of public and private initiatives, see William Easterly and Luis Serven (2003), *The Limits of Stabilization: Infrastructure, Public Deficits and Growth in Latin America*, World Bank, xv-208.

[5] *Water Governance for Poverty Reduction: Key Issues and the UNDP Response to Millennium Development Goals* (2004), United Nations Development Programme, 1-93.

[6] "Review of the water supply and sanitation sector benchmarking practices and models in the EU and other regions", Report for 6th EU Framework Programme for Research and Technological Development. March 1, 2004.

[7] See Coelli et. al. (2003), *A Primer on Efficiency Measurement for Utilities and Transport Regulators* (WBI Development Studies)

[8] Glenn Pearce-Oroz , "The viability of decentralized water and sanitation provision in developing countries: the case of Honduras" ,*Water Policy* 8 (2006) 31–50.

[9] The ICT index includes connectivity and access to computers; http://www.who.int/ehealth/resources/countries/en/index.html#C

[10] GNI is the total value of goods and services produced within a country, together with its income received from other countries (interest and dividends) less similar payments made to other countries. GNI is calculated by the Atlas method, in current Dollars – source *World Development Indicators 2006* – World Bank website query.