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Optimal Size for Utilities?

Returns to Scale in Water: Evidence from Benchmarking

Nicola Tynan and Bill Kingdom

Nicola Tynan (tynann@dickinson.edu) is an assistant professor in the Economics Department of Dickinson College. Bill Kingdom (wkingdom@worldbank.org) is lead water and sanitation specialist at the World Bank.

The data used in this Note are from the International Benchmarking Network (IBNet), sponsored by the U.K. Department for International Development and the World Bank (http://www.ib-net.org/wb/uom_bench.asp).

Using data from 270 water and sanitation providers, this Note investigates the relationship between a utility's size and its operating costs. The current trend toward transferring responsibility for providing services to the municipal level is driven in part by the assumption that this will make providers more responsive to customers' needs. But findings reported here suggest that smaller municipalities may face higher per-customer costs and could lower costs (and prices for consumers) by merging.

Water and sanitation services involve large shared infrastructure costs, and adding more customers usually means that each one pays a smaller share of these costs. As systems become larger, however, growth in the administrative and coordination costs of running them can start to outweigh gains in the unit costs of service provision—the so-called X-inefficiency. In addition, the costs of expansion to more remote settlements can start to raise unit capital costs when averaged across the entire service area, an important contributor to total costs. Moreover, greater decentralization of water service delivery brings growing political challenges to establishing bigger systems.

Earlier econometric research using data from high-income countries concluded that water providers may operate cost-effectively through a range of sizes, with even small utilities facing economies of scale that can be significant.[1] This Note provides a first look at the link between a provider's size and its unit costs using data from low-, middle-, and high-income countries. It shows that utilities, particularly those serving a population of 125,000 or less, could reduce per-customer operating costs by increasing their scale of operation.

Cross-country study

The study covers 33 countries and 83 utilities in Africa, 26 utilities in Indonesia, 41 in Peru, 64 in the United States, and 56 in Vietnam. It uses data on the utilities' costs and on their size measured in four ways (table 1).

A standard econometric model is used to estimate economies of scale. The model implicitly assumes that economies of scale do not vary with the size of utilities. A review of the data shows that this is a plausible starting point, particularly for the non-Africa data sets. In a second step

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each data set is split between small and large utilities. This split allows economies of scale to differ for each subset, an outcome that would be expected if there is a minimum scale for efficient water provision and some small utilities in the sample fall below this threshold.

Results for all utilities

Using the estimated economies of scale for each data set and each measure of size, the analysis calculates how much operation and maintenance costs would increase with a doubling of size (table 2). In Africa, for example, a utility that doubles the size of the population it serves would increase its costs by only 61 percent. Overall, the results show economies of scale in 10 cases, constant returns in 7, and diseconomies of scale in the other 3.

In Vietnam the benefits of increasing scale may be quite large for some utilities. Doubling the population or number of customers served would increase costs by only around 75 percent. Results for Africa also show fairly strong evidence of economies of scale. In Africa a large number of shared connections might explain the sharp fall in unit costs resulting from an increase in population served. But this factor may account for only part of the effect, since increasing the number of connections also reduces unit costs.

Doubling the length of a utility's network results in constant returns for three data sets, a finding consistent with the results of earlier studies. For utilities delivering water over long distances, higher distribution costs can swamp other cost savings.

Only for Peru do the results suggest little benefit from increasing utility size. Results for two measures of size suggest constant returns to scale, and those for the other two, diseconomies of scale. This marked difference for Peru might mean that the relationship between a utility's size and its costs depends on its customer mix or on the range of services it provides. Large utilities might supply relatively more residential customers than small utilities do, or they may offer a broader range of services—both of which would raise unit costs. This was a conclusion Feigenbaum and Teeples (1983) reached in explaining apparent diseconomies of scale facing water and sanitation utilities in the United States.

Results for small utilities

Is the assumption that small and large providers face the same economies of scale valid? Or do small providers have more to gain from expansion than large providers? To address these questions, the data sets are split between small utilities (serving a population of 125,000 or less) and large ones. Splitting the data sets does change the reported economies of scale for each subsample, though the difference is not statistically significant. The effects on costs of doubling utility size are measured using two indicators of size—volume of water produced and number of

Table 1 Average costs and size of water utilities in the cross-country study

Indicator	Africa	Indonesia	Peru	United States	Vietnam
Annual operation and maintenance costs (US$ thousands)	1,228	1,568[a]	6,033[a]	21,730	0.6[b]
Population served	1,252,621	232,294	372,794	449,312	108,756
Connections or customers	121,876	39,513	47,756	84,909	14,745
Volume of water produced (millions of cubic meters a year)	33.9	18.3	28.0	70.7	6.8
Length of distribution network (kilometers)	943	601	479	1,187	144

Note: The data are for 1999 (Africa), 2000 (Africa and Vietnam), or 2001 (Indonesia, Peru, and the United States). They are compiled from national benchmarking initiatives using standard indicators developed by the International Benchmarking Network.
a. Based on official exchange rate for 1999.
b. Based on official exchange rate for 2000.
Source: For utility data, IBNet country data sets (http://www.ib-net.org/asp/performance_countries.asp); for exchange rates, World Bank, Global Development Network Growth Database (http://www.worldbank.org/research/growth/GDNdata.htm).

Table 2 Increase in costs when all water utilities double in size (percent)

Indicator of size	Africa	Indonesia	Peru	United States	Vietnam
Population served	61*	103	107	91*	73*
Connections or customers	79	109	112*	98	78*
Volume of water produced	90	95	101	89*	89
Length of distribution network	101	92	102	99	75*

* Significant at 95 percent.
Note: Cost increases of less than 95 percent indicate economies of scale, those of 95–105 percent constant returns to scale, and those of more than 105 percent diseconomies of scale.
Source: Authors' calculations based on data from IBNet country data sets (http://www.ib-net.org/asp/performance_countries.asp).

connections—chosen because they have relatively good explanatory power (table 3).

The results show that small providers and their customers have the most to gain from expansion. This is the case whether volume of water produced or number of connections is used as the measure of size. For Africa the difference between small and large utilities in reported economies of scale fits with the view that administrative and distribution costs facing national utilities may eventually outweigh the gains from shared infrastructure.

Conclusion

Taking a narrow approach to the data, this Note assesses the economies of scale facing water and sanitation providers by investigating operating costs as a function of the size of the service provider. In doing so, it makes two important assumptions. First, it treats each measure of size independently. Since the cost effect of adding a connection will vary with the additional length of network required or volume of water consumed, a fuller analysis would need to isolate the interdependence between different measures of size. Second, the modeling assumes that each service provider faces the same settlement pattern. In reality, settlement patterns differ widely, leading to large differences in network lengths, pumping requirements, and customer service arrangements. Thus adding to the population served through expansion in built-up urban areas would probably have different scale effects than doing so through expansion to dispersed villages or less densely populated secondary towns.

Nevertheless, using five different data sets, the analysis does find evidence that providers could reduce unit operating costs by increasing the size of their operation. Evidence for scale economies is most consistent across data sets when volume of water produced is used as the measure of size. But strong economies of scale also show up for some data sets when the measure of size is number of connections or popula-

Table 3 Increase in costs when small and large water utilities double in size (percent)

Indicator of size and utility size class[a]	Africa	Indonesia	Peru	United States	Vietnam
Volume of water produced					
Small	63	81	76	86	75
Large	118	89	98	97	75
Connections or customers					
Small	53	50	105	98	73
Large	99	113	109	104	98

Note: Cost increases of less than 95 percent indicate economies of scale, those of 95–105 percent constant returns to scale, and those of more than 105 percent diseconomies of scale.
a. Small utilities are those serving a population of 125,000 or less, large utilities those serving more than 125,000.
Source: Authors' calculations based on data from IBNet country data sets (http://www.ib-net.org/asp/performance_countries.asp).

tion served, though the results are more varied. This difference suggests that the optimal size for utilities is more sensitive to customer characteristics than to the volume of water produced.

The current trend toward transferring responsibility for providing water and sanitation services to the municipal level is driven in part by the assumption that this will make providers more responsive to customers' needs. Without challenging the benefits of decentralization, the findings here suggest that smaller municipalities may face higher per-customer costs. While the findings are based on providers in particular locations and so should be used with caution, they nevertheless suggest that neighboring small providers may be able to lower customer charges by operating as one utility. That conclusion makes sense. It also has important implications for the sector:

- Forming such a group can be complex. In some countries small municipalities are encouraged or required to group together. In others the market providers sell their services to multiple municipalities. Both approaches deliver scale economies not available to individual municipalities.
- The size of the group affects its attractiveness to the private sector. Individual municipalities may be attractive to small entrepreneurs, while larger groups will hold more interest for national or even regional companies. The largest groups may attract international operators.[2]

Notes

1. Since 1998 four studies have estimated scale economies in the water industry, using data from the United States (Kim and Clark 1998), the Republic of Korea (Kim and Lee 1998), France (Garcia and Thomas 2001), and Japan (Mizutani and Urakami 2001). All the studies found evidence of economies of scale for small utilities, though their definition of *small* varies.

2. These important issues are being further studied as part of the World Bank's Small Towns and Multi-Village Initiative (http://www.worldbank.org/watsan/topics/small towns.html).

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To order additional copies contact Suzanne Smith, managing editor, Room F 4K-206, The World Bank, 1818 H Street, NW, Washington, DC 20433.

Telephone:
001 202 458 7281
Fax:
001 202 522 3480
Email:
ssmith7@worldbank.org

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