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STATE VERSUS PRIVATE SECTOR PROVISION OF WATER SERVICES IN AFRICA: AN EMPIRICAL ANALYSIS

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Abstract

Under pressure from donor agencies such as the World Bank, a number of developing countries have experimented with the privatisation of water services. This study reviews the existing econometric evidence on the effects of water privatisation in developing economies before presenting new results using statistical, data envelopment analysis (DEA) and stochastic cost frontier techniques and data from Africa. The study fails to find evidence of better performance in private utilities compared to state-owned utilities. The paper then considers reasons why water privatisation could prove problematic in lower-income economies, identifying the technology of water provision and nature of the product, transaction costs and possible regulatory weaknesses.

Key words: water services, privatisation, developing countries, performance, efficiency.

1. Introduction[1]

Access to water is crucial to life and health and the provision of safe and affordable water services remains a priority for most developing economies. According to the World Bank (2003, p.1) more than 1bn people in the developing world lack access to clean water and nearly 1 .2bn lack adequate sanitation. It is estimated that 1 2.2m people die every year from diseases directly related to drinking contaminated water. The inclusion of a water access target in the Millenium Development Goals – to halve the proportion of people without access to safe drinking water by 2015 – is a recognition of the importance of safe water supply in reducing poverty in the developing world (Calderon and Serven, 2004).

One of the major causes of poor access to water services is the inefficiencies of the water utilities which mainly serve the urban areas. The water utilities are predominantly in public ownership, and in many systems as much as a third of production is lost, revenues are insufficient to cover operating costs and the quality of the water is poor (World Bank, 2004a, p.220). Faced with the deterioration in water sector performance, donor agencies have advocated the privatisation of public utilities in lower-income economies to promote more efficient operation, increase investment and service coverage, and to reduce the financial burden on government budgets (World Bank, 1995). In response, a range of services including water supply have been opened up to private capital (World Bank, 2003; Harris, 2003). Private participation in water, however, has been less common than in other infrastructure sectors, and the pace of reform has been slower and harder to sustain politically (World Bank, 2004: p220). Although privatisation appears to have the potential to improve water services and meet the needs of the poor, it may be difficult to achieve. The possible reasons relate to the technology of water provision (high fixed costs and location specificity), which severely restrict the prospects for competition, the transaction costs of organising long-term concession agreements and regulatory weaknesses. There is also the difficulty of balancing adequate returns to investors and ensuring that water services remain affordable to the poor.

The pressing challenge for public policy towards the water sector is to meet both efficiency and social welfare objectives, and to determine the extent to which privatisation is critical to achieving the Millenium Development Goal for safe, accessible and affordable water services. This paper explores these issues by examining the impact of water services privatisation in Africa. It begins with a review of the existing econometric evidence on the impact of water privatisation. We then provide results using a data set for African water utilities using statistical, DEA and stochastic cost frontier measures to triangulate the evidence and to assess consistency across the results.[2] Data availability restricted the number of dimensions of performance that we were able to estimate, however, the results for cost efficiency and service quality fail to show that performance of privatised water utilities is superior to that of state-run firms. The paper goes on to consider the difficulties that face privatisation and regulation in water services, in terms of the technology of water provision and the nature of the product, transaction costs and regulatory weaknesses. That data deficiency may explain our failure to identify better performance under private operation is recognised.

2. The Existing Evidence

Private water suppliers exist in all developing countries in the form of water vendors at the street level, but there was little privatisation of piped water services in developing countries before 1990 (Snell, 1998; Collignon and Vézina, 2000). Where privatised services existed, for example in Cote d'Ivoire, these were usually French speaking ex-colonies that had inherited a reliance on private firms for water services, as exists in France. Between 1984 and 1990 only eight contracts for water and sewerage projects were awarded to the private sector world-wide and the cumulative new capital expenditure in private water services totalled less than US$ 1bn.

However, during the 1990s there was a significant increase in water privatisation activity, stimulated by donor agency pressures, and in 1997 the total figure for private investment had risen to US$25bn (World Bank, 2003). By the end of 2000 at least 93 countries had privatised some of their piped water services, including Argentina, Chile, China, Colombia, the Philippines, South Africa and the transition economies of Central Europe, as well as Australia and the UK (Brubaker, 2001). Based on the World Bank public-private investment (PPI) data base and taking the period from 1990 to 2002, there were 106 such projects in Latin America and the Caribbean and 73 in East Asia and the Pacific region. By contrast there were only seven projects in the Middle East and North Africa and 14 in sub-Saharan Africa. In terms of the amounts invested, Latin America and the Caribbean and East Asia and the Pacific accounted together for over 95 per cent of the total investment. Table 1 provides a summary of the largest investments in water services during the period 1990 to 2002. Clearly, a small number of countries accounted for most of the privatisation of water services, and within these countries the figures were dominated by a few large contracts. Indeed, one project, Aguas Argentinas, accounted for US$4.9bn or 20 per cent of the investment in the whole of Latin America; while five Philippines contracts accounted for 38.4 per cent of the total private investment in water services in East Asia.

(Table 1 here.)

Past studies of privatisation have indicated that competition is generally more important than ownership, *per se,* in explaining performance improvements in developing countries (e.g. Zhang et al., 2003; Parker and Kirkpatrick, 2005). But unlike in the case of telecommunications and parts of energy supply, such as generation, where competition is feasible, competition in the market for water services is usually cost inefficient. While there is scope for introducing some competition into billing and metering and into construction, replacement and repair work within water services, competition in the actual provision of water supplies is normally ruled out by the scale of the investment in network assets that are needed to deliver the product. Moreover, even where actual competition for consumers might seem feasible, for example where the boundaries of different water utilities meet, the costs of moving water down pipes is far higher than the costs of transmitting telephone calls and distributing electricity, and this places a serious limitation on the development of competition. Also, mixing water from different sources can raise complications in terms of maintaining water quality, which can be an important consideration for domestic consumers but more especially water-using industries, such as brewing and food processing. In other words, the technology of water supply and the nature of the product, together, severely restrict the prospects for competition in the market and therefore the efficiency gains that can result from encouraging competition following privatisation. This leaves rivalry under privatisation mainly taking the form of 'competition for the market' or competition to win the contract or concession agreement.

Evidence suggests that privatisation in non-competitive markets produces ambiguous results in terms of improving economic performance (Megginson and Netter, 2001) and emphasises the need for effective regulation of the privatised utilities. It is to be expected, however, that the institutional requirements to ensure that privatised monopolies perform well, notably an effective system of state regulation and supporting governance structures, will be particularly missing in many developing countries (Parker and Kirkpatrick, 2005). This represents a further difficulty in achieving significant performance improvement in the short term, by means of water privatisation.

Privatising water services is normally associated with contracts that take the following forms, namely, service contracts (contracts to provide specialist services such as billing), management contracts and leases for existing facilities (private companies operating existing facilities but without new private sector investment), concessions (requiring the private sector to invest in facilities), divestitures (sale by the state of some or all of the equity in SOEs) and greenfield investments (including build-operate-transfer [BOT] type schemes) (Johnstone and Wood, 2001, pp.10-1 1; World Bank, 2004a, p228). In practice, contracts under which private firms provide the services but government remains the ultimate owner of the water system and may remain responsible for some investment are commonplace (OECD, 2003). Of 233 water and sewerage contracts with the private sector arranged between 1990 and 2002 on the World Bank's PPI Project Database, 40 per cent involved concession contracts and these accounted for 64 per cent of the total amount invested. Where greenfield projects have occurred, for instance in China, they have often involved the building and operation of new water treatment plants and BOT schemes for water supplies have been common in Latin America and the Caribbean. Divestitures or the sale of state-owned water businesses to the private sector have been rare, accounting for only 15.6 per cent of all water projects and 8 per cent of the total funds invested. Also, although privatisation of water services has occurred, it is important not to exaggerate its importance. At present, little more than 5 per cent of the world's population is provided with drinking water through private operators (OECD, 2003) and since the Asian economic crisis of 1997/98 there has been a marked slow down in infrastructure privatisation in lower-income economies, including in the water sector (Harris, 2003). Moreover, the main forms that water privatisation take raise issues about the transfer of risk from the public to the private sector. We return to this subject later in the paper in a discussion of transaction costs in water service contracting.

The existing case study evidence on the results of water privatisation presents a mixed picture, with some improvements in labour productivity and operating costs and in the reliability and quality of services and the percentage of the population served (e.g. Crampes and Estache, 1996; Estache, et al., 2001; Galiani et al., 2002; Shirley and Menard, 2002; World Bank, 2004a, pp.252-257). Balanced against this there is some evidence of higher water charges and resulting bouts of public opposition leading to cancelled schemes. The evidence is reviewed in Kirkpatrick and Parker (2005), also Shirley (ed) 2002. Turning to the few published papers that have attempted a statistical or econometric analysis of the effects of water privatisation in lower-income economies, these too present little evidence that privatisation has resulted in a marked improvement in performance. Estache and Rossi (2002) compared private and public water companies in the Asian and Pacific region, using 1995 survey data from the Asia Development Bank. Adopting stochastic cost frontier modelling and applying error components and technical efficiency effects models, they concluded that efficiency was not significantly different in the private and state water sectors. Fifty water enterprises were included in their study from 29 Asian and Pacific-region countries, with 22 having some form of private sector participation.

A further study, this time by Estache and Kouassi (2002), used a sample of 21 African water utilities for the period 1995/97. They estimated a production function from an unbalanced panel data set and used Tobit modelling to relate resulting inefficiency scores to governance and ownership variables. The study found that private ownership was associated with a lower inefficiency score. However, only three firms in their sample had any private capital and levels of corruption and governance were far more important in explaining efficiency differences between firms than the ownership variable.

Finally, a study of water supply in Africa in the mid to late 1990s by Clarke and Wallsten (2002) reported greater service coverage under private ownership. On average, they found that supplies for lower-income households (proxied by educational attainment) were smaller where there was a state-sector operator. Clarke and Wallsten, therefore, concluded that private participation in water schemes leads to more supplies to poorer households than where there is a reliance on state-owned suppliers. Their study suggests that privatisation can improve service provision. However, there may be offsetting service difficulties and especially higher charges when supplies are privatised. In other words, drawing strong conclusions on the desirability of water privatisation based on one measure, such as service coverage, may mislead. In the analysis below we use a range of performance measures in an attempt to address this problem.

3. Assessing Performance in Privatised African Water Utilities

To advance understanding of the results of privatisation in water services, we accessed data from the Water Utility Partnership's SPBNET Africa web site (http://www.wupafrica.org/spbnet/angl/index.html). The SPBNET data base includes up to 110 water utilities in Africa and was developed with financial and technical support from the Department of International Development (DFID) in London. The data collected, usually by questionnaire survey, relate mainly to the year 2000.[3] The data set used for this study has 13 countries including 14 utilities that reported private sector involvement.[4] However, not all of these firms could be included in each stage of the analysis because of incomplete data entries. Suppliers are categorised as either state owned or privately owned, with the latter capturing the various institutional options for private sector involvement in the water sector, including management and leasing contracts. Ideally we would use information on the forms that private-sector involvement takes to judge the degree of privatisation, but unfortunately the data source only permitted ownership to be modelled as a binary variable. This is a limitation of our study, but a limitation shared with the earlier econometric studies referred to above. More generally, the data set is characterised by heterogeneity, small sample size and small number of privatised firms. The data limitations mean that the results must be treated as tentative.

Conclusions on the impact of water privatisation may be sensitive to the precise performance measure used. Therefore, to assess the impact of private capital on performance in water services, a range of performance measures was calculated. Firstly, a number of statistical measures were computed from the data set, including:

- Labour productivity – labour costs to total costs, number of staff to number of water connections and staff per million cubic metres of water distributed – all of these measures will reflect *eficiency in the use of labour*.
- The proportion of operating costs spent on fuel and chemicals – to reflect *economies in non-labour operating costs.*
- The percentage of capital utilised – to reflect *capital stock eficiency.*
- Average tariffs – to reflect the *costs of services to consumers.*

- The percentage of the population served, unaccounted for water (water losses), and hours of availability of piped water per day – to reflect the *quality of service to consumers*.

Average figures were computed for both state-owned and privately-owned water suppliers and the results are provided in Table 2, with standard deviations shown in parentheses. This stage of the analysis involved between 61 and 84 utilities depending upon the performance measure.

(Table 2 here.)

The figures in Table 2 show that, *on average,* private sector water utilities have higher labour productivity (both a lower number of staff to number of connections and per million cubic metres of water distributed) and a lower proportional spend on labour in operating costs than state-owned firms. On average, the private sector is also more economic in its use of other inputs, namely fuel and chemicals, and achieves a slightly higher capital utilisation, of 67 per cent as against 60 per cent. Hence, the private sector seems superior in terms of production efficiency. Turning to tariffs, charges are on average 82 per cent higher in the private sector and more customers have their water consumption metered where services are privatised.[5] Metering water can be a means of extracting higher revenues from consumers by linking payments to the volumes of water used. The private sector also achieves a lower percentage of water losses, averaging 29 per cent as against 34.8 per cent for state-owned water firms (probably assisted by more metering). But, interestingly, other measures of customer service suggest smaller differences between the private and state sectors. On average, state-owned firms supply piped water for 17 hours per day, while the private sector records a slightly lower figure of 16 hours. The state and private sectors serve about the same percentage of population in their areas, 63 per cent and 64 per cent respectively.

The standard deviation figures in parentheses in Table 2 confirm a high degree of variance in performance within both the state and private sector categories for each of the measures. These results suggest that conclusions based on average performance need to be interpreted with care. This is confirmed by the F-test results (shown in the final column of Table 2) for the difference in means for the public and private utilities' performance ratios, none of which are statistically significant. Also, calculations using the SPBNET data base suggest that in Africa privately-owned water utilities are on average over twice as large as state-owned ones in terms of the total volume of water distributed (92m as against 36.4m cu.mts. per day) and have more connections to their systems (averaging 159,600 in the case of the private utilities, as against 94,500 in the case of the state-owned firms). This may partially account for the private utilities' somewhat better performance in terms of labour productivity.

Therefore, to provide a fuller appraisal of relative performance two further sets of performance measures were calculated, drawing on the same data base, using stochastic frontier analysis (SFA) and data envelopment analysis (DEA).

The Cost Function Analysis

A cost function was estimated on the basis of the SBPNET database. The reason for choosing a cost frontier instead of a production frontier lies in the fact that most water utility firms are required to meet demand and are not free to choose the level of output. With output set exogenously, the firm is expected to minimise the costs of producing a given level of output. The coefficients of the cost function can be estimated by OLS regression analysis. Alternatively, a stochastic cost frontier model estimated by the Maximum Likelihood (ML) method can be used. Compared to the OLS model, the stochastic cost frontier model decomposes the error term into stochastic noise (v_i) and cost inefficiency (μ_i).

Various distributions have been suggested for the inefficiency term in the stochastic cost function. Two of the most commonly used are the half-normal distribution (Aigner, Lovell and Schmidt, 1977) and truncated-normal distribution (Stevenson,1980). The truncated-normal distribution is a generalisation of the half-normal distribution, obtained by the truncation at zero of the normal distribution, with mean, μ, and variance, σ_i^2. Pre-assigning μ to be zero reduces the truncated distribution to half-normal. The appropriate model for estimation can be determined by testing the null hypothesis H_0: μ=0. If the hypothesis μ=0 is rejected, this means that the assumption of the truncated distribution is correct. If μ is not significantly different from zero, a model assuming a half-normal distribution should be estimated instead.

Following the parameterisation proposed in Battese and Correa (1977), σ_i^2 and σ_v^2 are replaced with $\sigma^2 = \sigma_i^2 + \sigma_v^2$, $\gamma = \sigma_i^2/(\sigma_i^2 + \sigma_v^2)$. This is done to allow the application of maximum likelihood estimates. The parameter γ lies between 0 and 1, with 0 indicating that the deviation from the frontier is due entirely to noise and 1 indicating that deviation is due purely to inefficiency. The superiority of a stochastic frontier can be tested by the null hypothesis, $H_0: \gamma = 0$. If the null hypothesis cannot be rejected, this indicates that the inefficiency term should be removed from the model, leaving a specification with parameters that can be consistently estimated using OLS.

The stochastic cost function has been widely specified as a Cobb-Douglas function or as a translog cost function. A generalised likelihood–ratio test was used to test whether a Cobb-Douglas function was appropriate. The result showed that the null hypothesis of the Cobb-Douglas specification cannot be rejected. In addition, Leamer’s extreme bound analysis was conducted and it showed that the range of the coefficients of the key variables for the Cobb-Douglas function was much smaller than that of the translog model.[6] This confirms that the employment of the Cobb-Douglas specification is appropriate. In order to account for variable return to scale, the quadratic term of the output variable was included, however, the coefficient was statistically insignificant.[7] A likelihood ratio test was conducted and the results also pointed to the standard Cobb-Douglas specification.

Following the literature, we estimated the cost function using data on the cost level, the output level and input prices. Data availability required us to use operating and maintenance costs (COST) or non-capital coats, as the dependent variable in the cost frontier. An arbitrary cost function was therefore formulated which excluded the price of the capital input.[8] Average manpower cost per employee (MP) was used to reflect the cost of labour, and material costs per unit of water distributed (MAT) were included as an additional determinant of non-capital costs. The amount of water distributed per year (WD) was included in the cost function as the output variable. Also included in the function was a quality variable, measured by the hours of piped water available per day $(QUALI)$.[9]

A number of control or environmental variables were also included to capture cross country heterogeneity in the political, legal and economic environment.[10] Good governance in the form of sound finance and regulatory systems and protection of property rights has been found to be an important explanation of economic performance differences (North, 1990; Jalilian et al., 2002; Kaufman et al., 2002), including in water services (Estache and Kouassi, 2002). The freedom variable (FRD) developed by the Fraser Institute (http://www.freetheworld) was therefore included to capture wider governance or regulatory effects on performance in water utilities, which might otherwise have been attributed to ownership. An index of property rights (PROPERTY) was used as a measure of the quality of the investment environment. The fiscal balance variable (BALANCE) proxies the quality of macro economic management in the form of budgetary policy. A density variable, measured by population served per connection (DEN), was included because it plays an important role in defining the network infrastructure.[11] Another variable used as a control was the annual water resources per capita (WRS). GDP per capita (GDP) was included in an attempt to capture the extent of economic development. Finally, to account for the effects of ownership on performance, a dummy variable (ONS) was included in the model, which took the value of 1 if the utility had private capital, as defined earlier.

All variables except the ownership variable and those in index or percentage terms were logged. In total 76 observations were included in the estimations, including ten private sector operations. The programme FRONTIER 4.1 was used to obtain the maximum likelihood estimates of the parameters and the efficiency measures. The procedure for estimation was as follows. An Error-Component (EC) model was first estimated with the assumption of a half-normal distribution for the inefficiency term. [12] In order to test the robustness of the results on ownership, a Technical Efficiency Effects (TEE) frontier was then estimated in which the inefficiency effects were expressed as a function of the ownership dummy.[13]

The first three columns of Table 3 show the results for the EC model. The OLS estimates are also shown in the table for comparative purposes. The value of γ in the EC model suggests a high (0.98) ratio of the variance of inefficiency to the total residual variance.[14] Analogously, the high value of γ means that the stochastic frontier is superior to OLS modelling in explaining the cost structure of the water utilities. This is also confirmed by the generalised likelihood –ratio (LR) statistic, which exceeds the critical value at the 1 per cent level.[15] We therefore concentrate on the Maximum Likelihood (ML) results in Table 3.

(Table 3 here)

From the results of the half-normal EC model, it can be seen that the output variable, ln(WD), has a positive and significant effect on operating costs. This is in line with normal expectation. Similarly, the variables of service quality (ln(QUALI)), labour price (ln(MP)) and material cost (ln(MAT)) are all significant and correctly signed. The negative and statistically significant (at the 10 per cent level) coefficient for the water resources variable (lnWRS) is also consistent with our expectations. We would expect that the costs of water production and distribution tend to be lower in countries where water resources are abundant. The negative coefficients of income per capita (ln(GDP)) and the freedom index (FRD) suggest that the operational costs of the utilities may be lower in countries which are wealthier and sounder in terms of general institutional governance. However, the effects are not statistically significant. More robust evidence of the influence of institutional development is provided by the property rights variable (PROPERTY) which shows negative and significant effects on the cost level. This indicates that costs are lower in countries where property rights and therefore private investment are better protected. The impact of the government fiscal management measure (BALANCE) appears to be trivial. Contrary to our expectation, however, the results for the density variable (DEN) are statistically insignificant. Turning to the role of ownership, which is our main concern, the coefficient of the ownership dummy (ONS) is positive, suggesting that private ownership is associated with higher costs. However, the result is not statistically significant.

In order to determine the robustness of this result, we estimated a TEE model in which the inefficiency term was expressed as a function of the ownership dummy. In the TEE model the inefficiency error $ì_i$ has a mean of m_i and $m_i = ä x_{i} . x_{i}$, which is a vector of variables that may influence the efficiency of a firm. This was taken as the ownership dummy in our estimation. The results of the ML estimation (Table 3, final column) show that the coefficient δ(ONS) is positive but not statistically significant. This finding is consistent with the outcome from the EC model for ownership.

The Data Envelopment (DEA) Analysis[16]

A DEA analysis was also undertaken in which water distributed was represented by the volume of output produced and hours of piped water available per day was used as the proxy for the quality of water services (unaccounted for water and the percentage of samples that failed to meet the quality standards were also used as the quality of service proxy and the results were very similar). An input-oriented, variable returns to scale model was adopted to allow for the variation in size of the utilities.[17] The number of utilities entered into the analysis was 66 of which nine were private. The inputs used were manpower cost per employee (because number of staff would not reflect the average skill level of staff[18]), material cost per unit of water distributed and the number of water treatment works. Using a Tobit model, the efficiency scores from the initial DEA analysis were regressed on the control variables, namely, DEN, WRS, GDP, FRD, PROPERTY, AND BALANCE (as defined earlier). The results of the Tobit analysis showed that only DEN and PROPERTY were statistically significant, and these two variables were included as control variables in a second stage DEA analysis.[19]

Table 4 summarises the final DEA results according to the number of utilities that achieved a score of 100 per cent efficiency, 90 per cent to 99 per cent efficiency and 80 per cent to 89 per cent efficiency under private and state operation.[20] Significantly, state-owned firms help to form the efficiency frontier, suggesting that state ownership does not necessarily lead to low relative efficiency. The number of state-owned firms on the frontier amounted to 32 out of the 57 firms or 53 per cent of the total of state-owned firms in the data set. Six of the nine private operations included in the analysis populated the frontier. The DEA results appear to be consistent, therefore, with the SFA analysis, in suggesting that the efficiency performance of state-owned water firms in Africa can be comparable to that of private enterprises. However, the results provide stronger evidence for possible higher relative efficiency in the private sector as a whole, although it should be born in mind that there are only nine private firms in the sample. For example, no utilities with private sector involvement have less than 70 per cent relative efficiency and 67 per cent of private as against 53 per cent of state operations populate the frontier.

(Table 4 here.)

4. Transaction Costs and Water Concessions

Before concluding the paper, it is interesting to consider why privatisation of water services may be problematic in lower-income economies. The answer seems to lie in a combination of the technology of water provision and the nature of the product, the costs of organising long-term concession agreements or transaction costs, and regulatory weaknesses, to which we now turn.

As already explained, the technology of water supply and the nature of the product, together, severely restrict the prospects for competition in the market and therefore the efficiency gains that can result from encouraging competition following privatisation. This leaves rivalry under privatisation mainly in the form of ‘competition for the market’ or competition to win the contract or concession agreement. However, here serious problems can arise. These problems relate to the existence of pervasive transaction costs. Transaction costs arise in contracting for water services provision, in terms of the costs of arranging the agreements, including organising the bidding process, monitoring contract performance, and enforcing the contract terms where failures are suspected (Williamson, 1985). The economics literature suggests that such costs are likely to be high where there are serious information asymmetries at the time of the contract agreement. These information imperfections are likely to be especially prevalent when contracts have to be negotiated to cover service provision over long periods of time because many future events that could affect the economic viability of the contract and the acceptability of the service offering are unforeseen, and may be unforeseeable. Concession agreements in water are typically negotiated for 10 or 20 years or more. Inevitably, therefore, the contracts will need to permit periodic adjustment of variables such as price, volume and quality during the contract life. The contract will be incomplete in terms of specifying all of the contingencies that may trigger such adjustments and the form the renegotiation might take. This places a large emphasis on the skills of both government and companies when operating water concessions, to ensure as far as possible that the outcome is mutually beneficial.

The usual approach in water concessions is to have a two-part bidding process. The first stage involves the initial selection of approved bidders, based on technical capacity, and then a final stage in which the winner is selected, based on criteria such as the price offered and service targets. However, the smaller the number of bidders the greater the scope for actual or tacit collusion when bidding and the less effective will be the competitiveness of the bidding process. The evidence suggests that water concessions in developing countries are subject to small numbers bidding (McIntosh, 2003, p.2). For example, in 2001 18 companies expressed interest in operating a contract for Nepal in the first stage of the process, but in the final stage only two serious bidders remained (cited in Mitlin, 2002, p.1 7). In Argentina there have usually been only a small handful of applicants for water concessions, typically between two and four (Estache, 2002). In an attempt to stimulate interest from more potential suppliers, concessions can include sovereign (government or donor agency) guarantees of profitability, but this introduces obvious moral hazard risks – with profits guaranteed, what incentive exists for the concession winner to operate efficiently?

The literature on transaction costs also suggests that small numbers contracting is a source of opportunistic behaviour (Williamson, 1985). The result can be both adverse selection and moral hazard. Adverse selection takes the form of sub-optimal contracts at the outset, resulting from one of the contracting parties acting opportunistically to arrange especially favourable terms; while moral hazard occurs when one of the contracting parties renegotiates the terms of the contract in their favour during its lifetime. During contract renegotiation either the company or the government could be the loser, depending upon the results of the renegotiation.[21]

Guasch (2004) concludes that 75 per cent of water and sanitation concession contracts in Latin America and the Caribbean were renegotiated significantly within a few years of being signed – in Buenos Aires prices were raised within months of the start of the water concession (Alcazar et al., 2000). But even the ability to renegotiate terms may not be sufficient to overcome investor reluctance to participate in water privatisations, thus reinforcing the small numbers bargaining problem. Difficulties arise especially when private investors fear that there is no long term political commitment to water privatisation (Rivera, 1996). Moreover, corrupt payments to win concessions and 'cronyism' may compromise the legitimacy of the privatisation process; for example, in Lesotho the Highlands Water Project was associated with bribes to government officials (Bayliss, 2000, p.14). Esguerra (2002) shows how the water concessions in Manila were backed by the Philippines' two wealthiest families with support from multinationals: 'It appears that the two companies' approach was to win the bid at all costs, and then deal with the problems of profitability later' (ibid., p.2).

Studying concession contracts in developing countries, Harris et al. (2003) find that water and sewerage concessions have the second highest incidence of post-contract cancellation after toll roads. Given the existence of substantial potential 'sunk costs' in the water industry, this is not surprising. Tamayo et al. (1999, p.91) note that the specificity of assets in the water industry is three to four times that in telecommunications and electricity. Handley (1997) stresses the problems caused by inadequate risk management techniques in developing countries; while the preference on the part of the private sector for the state to remain responsible for the infrastructure in water contracting reflects the desire of companies to minimise their sunk costs. Transaction costs in water concessions reinforce serious weaknesses in government regulatory capacity in developing countries (Spiller and Savedoff, 1999, pp.1-2). For example, in India there have been some local moves to attract private capital into water supply, notably in Tiruppur, Maharashtra and Gujarat. But regulatory systems are underdeveloped and in Tiuppur they appear to be largely under the indirect control of the water operator (Teri, 2003, pp.1 71-21). As Mitlin (2002, pp.54-55) concludes on the experience in Manila:

> The experience in Manila suggests that the gains [from privatisation] may be less than anticipated because the assumption that the involvement of the private sector would remove political interference from the water sector was wrong. It may be that processes and outcomes have simply become more complex because the water supply industry now has the interests of private capital in addition to a remaining level of politicisation and an acute level of need amongst the poorest citizens.

To assess the effects of regulation on water privatisation in Africa we repeated our stochastic cost function analysis, but this time incorporating a regulatory variable as a dummy alongside the existing freedom variable (representing wider good governance in a country). The SPBNET data base provides information on the existence of regulation of prices, water quality and customer services. The different regulatory indicators were included separately in the regressions. We also combined the three measures into a composite regulation dummy to reflect the existence or lack of existence of regulation in water. Our expectation was that regulation would impact on costs depending upon the form regulation takes. For example, a good regulatory regime should create more investor certainty and may reduce the costs of capital. Alternatively, regulation could raise costs by imposing higher and more expensive quality standards or by raising uncertainty for investors. The results from this regression analysis showed that the composite regulation dummy and the water quality and services dummies each had a negative sign, suggesting that the existence of regulation lowered operating costs. However, these results were not statistically significant. The regulation dummy for tariff regulation was positively signed and statistically significant, suggesting that regulation of prices increased costs.

The findings from this stage of the analysis were, therefore, inconclusive.[22] Regulation, both sector specific and as reflected in the general standards of governance in a country, proved to be statistically insignificant. The single exception related to tariff regulation and this result is consistent with recent concerns that state regulation can raise costs (World Bank, 2004b). However, the regulation variables used are far from ideal and future research would benefit from developing a set of superior regulatory variables that more closely reflect the form of regulation rather than simply its existence.

5. Conclusions

This paper has reviewed the existing econometric evidence on the impact of water privatisation in developing countries and has reported the results of a new analysis for Africa, using a range of performance measures and data for 2000. The study has reported statistical indicators of performance and both DEA and stochastic cost frontier results. In principle, privatisation has the potential to improve water services in developing countries, reversing decades of underinvestment and low productivity under state supply. However, the results, taken together, do not provide strong evidence of differences in the performance of state-owned water utilities and water utilities involving some private capital in Africa. While the DEA results point tentatively to private sector superiority, the SFA provides some but statistically insignificant evidence that state-owned utilities have the better cost performance. The descriptive statistics suggest no statistically significant differences.

Our results therefore complement those of Estache and Rossi (2002), who also failed to find evidence of superior performance on the part of privately-owned water utilities in developing countries. Estache and Kouassi (2002) reported a statistically significant result for the effect of privatisation. However, this was based on data for three privatised utilities in a total sample of 21 water utilities in Africa, and governance and institutional factors were found to be much more significant in explaining performance. Admittedly our results contrast with the findings of Crampes and Estache, 1996, and Galiani et al., 2002, who concentrated upon service coverage. They concluded that privatisation led to benefits in terms of numbers provided with safe water and sanitation. We found no real difference in the percentage of the population served, but due to limited availability of data we were unable to explore this dimension of service in detail. We acknowledge that our findings like those of the earlier studies are dependent upon the data inputted and this was far from ideal. There is also the possibility that governments in Africa turned to private capital for the worst performing water utilities, thus making it less likely that we would find evidence of superior private sector performance.

The paper then considered some reasons why water privatisation might prove problematic in lower-income economies, identifying potential difficulties stemming from water supply technology and the nature of the product, transaction costs and regulatory capacity. These difficulties may help explain why private ownership does not have an unequivocally positive effect on performance in water supply in our and some earlier studies. By including regulation dummies in the stochastic cost frontier model, we attempted to shed further light on the importance of regulation, but the results were mainly statistically insignificant. This outcome may reflect the crudity of the regulatory variables used, which simply measure the existence of water regulation not its impact on the management of utilities. Under conditions of perfect competition, perfect information and complete contracts ownership does not matter (Shapiro and Willig, 1990) and the regulatory environment becomes trivial. However, none of these conditions applies to water services and it is to be expected that governance and regulatory variables will be important in determining performance pre and post-privatisation.

Finally, it needs to be stressed that the provision of affordable, safe and accessible water to the poor is a fundamental priority for low income countries. Policy makers and regulators are likely to face difficult trade-offs between allowing firms to charge prices high enough to recover costs and ensuring that poor households are provided with affordable water supplies, while at the same time attracting the necessary foreign capital and technical capabilities to upgrade and expand the water supply network. We found that private operation of water facilities is associated with much higher average water charges. Also, we found that private involvement tended to lead to more water metering - but what is the impact of this on water consumption and health? Water privatisation usually means the involvement of a handful of major international companies - but what effect does this have in terms of developing indigenous ownership and regulation of socially important assets?[23] Also, if privatisation leads to full cost recovery in water, is this outcome compatible with poverty reduction; and what are the environmental implications of privatisation? Clearly, water privatisation raises a complex set of political economy questions that deserve fuller exploration than has been possible here because of data limitations.

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Appendix 1 Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
Availability of piped water (hours per day)	2	24	17.17	6.989
Labour cost per employee (in PPP units)	134.49	88478.92	12806.64	17851.00
Material cost per unit water distributed (in PPP units)	0.00024	0.67	0.17	0.15
Number of connections (in thousand)	0.01	526.14	61.78	100.34
Total operating cost (in PPP units)	62812.45	1107688842.80	53038864.01	157294171.22
total volume of water distributed per year (cum)	8200	668000000	48258663.55	95605864.54

Table 1: Largest Investments in Water Services in Developing Countries, 1990-2002

	US$bn	**No. of projects**
Argentina	7.23	10
Philipines	5.87	5
Chile	3.95	13
Brazil	3.17	33
Malaysia	2.75	6
China	1.93	44
Romania	1.04	3
Turkey	0.94	2
Indonesia	0.92	8

Source: calculated using data from the World Bank PPI Project Database, http://rru.worldbank.org/PPI

Table 2: Performance Ratios in African Water Utilities: 2000

Performance Indicator	Average for State-sector operations (standard deviations in parentheses)	Average for private-sector operations (standard deviations in parentheses)	F- test for between-groups difference in means (probability statistics in parentheses)
Labour Productivity			
Labour costs in total costs (per cent)	29 per cent (17)	21 per cent (27)	1.45 (0.23)
Staff per thousand water connections	20.1 (19.9)	13.1 (14.4)	0.22 (0.65)
Staff per million m^3 of water distributed	123 (519.7)	78 (151.8)	0.18 (0.68)
Operating costs			
Proportion spent on fuel	20 per cent (16)	11 per cent (12)	0.44 (0.51)
Proportion spent on chemicals	17 per cent (16)	4 per cent (5)	2.37 (0.13)
Capital			
Capital utilisation	60 per cent (21.6)	67 per cent (21.8)	0.076 (0.79)
Consumer charges			
Average tariff (US$ per m^3)	168 (473)	305 (440)	1.9 (0.17)
per cent of customers metered	60 (41.5)	79 (38.4)	1.45 (0.23)
Quality of service			
Percentage of population served	63 (29.8)	64 (30.2)	0.22 (0.64)
Unaccounted for water	34.8 per cent (13.5)	29.0 per cent (13.1)	0.63 (0.43)
Availability of piped water (hours per day)	17 (6.7)	16 (9.3)	0.25 (0.62)

Table 3: The Stochastic Cost Frontier Results

EC model (half normal distribution)			TEE model		
Variable	***OLS***	***ML***	***Variable***	***OLS***	***ML***
constant	4.17 (2.60)***	1.18 (1 .65)*	constant	4.05 (2.47)**	1.55 (0.29)
Ln(WD)	0.76 (13.22)***	0.88 (29.49)***	*Ln(WD)*	0.76 (13.02)***	0.86 (23.97)***
Ln(QUALI)	0.12 (0.81)	0.14 (1.88)**	*Ln(QUALI)*	0.06 (0.38)	0.11 (1.80)**
Ln(MP)	0.26 (3.76)***	0.15 (4.33)***	*Ln(MP)*	0.25 (3.62)***	0.17 (5.28)***
Ln(MAT)	0.56 (8.20)***	0.65 (15.84)***	Ln(MAT)	0.56 (7.99)***	0.63 (8.25)***
Ln(WRS)	-0.001 (0.01)	-0.09 (1.48)*	*Ln(WRS)*	0.0009 (0.01)	-0.08 (0.22)
Ln(DEN)	-0.02 (0.44)	0.00003 (0.001)	*Ln(DEN)*	-0.028 (0.65)	-0.02 (0.10)
Ln(GDP)	0.09(0.85)	-0.01 (0.26)	*Ln(GDP)*	0.15 (1.40)*	-0.03 (0.31)
FRD	-0.13 (1.28)	-0.08 (0.22)	*FRD*	-0.12 (1.18)	-0.02 (0.54)
PROPERTY	-0.11 (1 .38)*	-0.05 (4.03)***	PROPERTY	-0.13 (1 .59)*	-0.06 (1 .83)**
BALANCE	0.02 (0.64)	-0.004 (0.32)	BALANCE	0.02 (0.53)	0.004 (0.09)
ONS	0.42 (2.00)**	0.15 (1.05)	δ (ONS)		0.11 (0.15)
ã		0.98 (0.63E+07)	ã		0.98 (0.21E+06)
LR test		34.63	LR test		44.53
Total Observations	**76**	**76**	**Total Observations**	**76**	**76**

*** significant at 1 per cent level
** significant at 5 per cent level *
significant at 10 per cent level

Table 4: Summary of the DEA Results

	Utilities with 100 per cent relative efficiency Number Percent		Utilities with efficiency of 90 per cent to 99 per cent Number Percent		Utilities with efficiency of 80 per cent to 89 per cent Number Percent		Utilities with efficiency of 70 per cent to 79 per cent Number Percent		Utilities with efficiency under 70 per cent Number Percent	
State	32	53	7	12	9	16	5	9	4	5
Private	6	67	1	11	1	11	1	11	0	0

The lowest score, 52.5, was recorded by a state-owned water utility in South Africa.

1 We would like to thank three referees and the editor for their comments on earlier drafts of this paper.

2 As Bauer et al. (1998) emphasise, we can have more confidence in comparative analysis if different measurements produce reasonably consistent conclusions.

3 Data for a few utilities relate to the years 1999 or 2001. Given the closeness of the years, we treat all of the data as applying to one year, 2000, to adopt a cross-sectional analysis of performance. The descriptive statistics for the sample are given in appendix 1.

4 Concession and management and lease contracts, together with privately owned assets, are categorised as private utilities. The utilities classified as private were cross-checked with the World Bank's PPI database. The countries in our database with private water utilities are Cape Verde, Cameroon, Cote d'Ivoire, Gabon, Ghana, Kenya, Nigeria, Morocco, Republic of Guinea, Senegal, South Africa, Tunisia and Zambia.

5 Admittedly, tariff figures have to be viewed with care as tariff levels are affected by public policy towards subsidies.

[6] We applied the Leamer's Extreme Bound Analysis to the Cobb-Douglas and the translog specifications. Accordingly, the output and input variables were treated as 'focus' variables and control variables as 'doubtful' variables. The bounds yielded from the Cobb-Douglas model were much narrower than those from the translog model. In addition, in the translog model the bound for the material input variable spanned zero. The results suggested that coefficients for the Cobb-Douglas model were more robust than those for the translog specification.

[7] The full results for these tests are available from the authors.

[8] A similar procedure is followed in Estache and Rossi (2002). In response to a referee's comment that the exclusion of a fixed capital measure may result in a misspecification of the cost function, we tested an alternative specification of the cost function where the number of water treatment plants was included as a proxy variable for capital costs. The results for the ownership variable were unaffected.

[9] Alternative quality indicators, namely unaccounted for water and the percentage of samples that fail to meet quality standards were also tested, with similar results.

[10] See Rodrik et al (2004) and Glaeser et al (2004) for a discussion of the use of institutional quality variables in quantitative analysis.

[11] We are grateful to a referee for pointing out that this density measure does not fully capture the dispersion of connections since it does not allow for the number of connections per building. Unfortunately, data on the more common measures of dispersion, such as connections per km of main or connections per square km, were not available.

[12] The Error Component model is the standard form of stochastic frontier model used in the literature. It decomposes the error term into stochastic noise and cost inefficiency. The results of the EC model with the truncated-distribution assumption showed that u was 0.47 with a standard error of 2.56. A likelihood ratio test was performed and the results showed that the hypothesis u=0 could not be rejected at the 10 per cent level. Consequently, the results from the model with the half-normal assumption were adopted.

[13] The Technical Efficiency Effect model can be used to investigate the determinants of technical inefficiencies among firms. Compared to the Error Component model, the Technical Efficiency Effects

Frontier is a stochastic frontier model that explicitly formulates technical inefficiency effects in terms of firm-specific factors. All parameters were estimated in a single-stage Maximum Likelihood procedure.

[14] A referee has pointed out that the error term may be capturing more than just inefficiency where there is misspecification because of heterogeneity and/or measurement problems. We accept this reservation.

[15] The critical value was obtained from Kodde and Palm (1986).

[16] We are grateful to Catarina Figueira for assistance with the DEA analysis.

[17] A constant returns to scale model produced a similar set of results but with lower overall scores.

[18] We thank one of the referees for drawing this to our attention.

[19] The inclusion of control variables in DEA analysis has been widely used in empirical studies, see, for example, Rugggiero, 1996, 2004; Paradi and Schaffnit, 2004. Wang and Schmidt (2002), however, are critical of this two-step procedure in DEA.

[20] DEA provides scores relative to peers with similar operating characteristics based on an estimated efficiency frontier. The resulting scores are relative not absolute scores. Therefore, a score of 100 per cent does not imply absolute efficiency but merely efficiency compared to the other units in the analysis. Similarly, SFA creates a frontier based on actual performances in the data set.

[21] For example, in the concession involving Maynilad in Manila, the company terminated the concession when it was refused a rate adjustment to which it considered it was entitled. By contrast, in Dolphin Bay, South Africa, the municipality felt that it had little alternative but to agree an unplanned price rise when the private sector supplier threatened to withdraw services (Bayliss, 2002, p.16).

[22] The detailed results can be obtained from the authors. A Tobit model was used to assess the impact of the regulation variables on the DEA scores discussed earlier. The results were also statistically insignificant.

[23] Kirkpatrick and Parker (2005) discuss the implications of liberalisation of water services under the WTO GATS for domestic regulation of water utilities.