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ABSTRACT

This paper updates the literature on water utility benchmarking studies carried out worldwide, focusing on scale and scope economies. Using meta-regression analysis, the study investigates which variables from published studies influence these economies. Our analysis led to several conclusions. The results indicate that there is a higher probability of finding diseconomies of scale and scope in large utilities; however, only the results for scale economies are significant. Diseconomies of scale and scope are more likely to be found in publicly-owned utilities than when the ownership is mostly private; as would be expected, multi-utilities are more likely to have scale and scope economies.

Keywords: economies of scale; economies of scope; meta-regression analysis; water utilities

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1. INTRODUCTION

In recent years, quantitative water sector studies have focused on measuring performance and identifying factors affecting costs. Until the 1980s only a handful of benchmarking studies could be found in the literature (papers in academic journals, PhD dissertations, working papers, chapters of books and books). In the 90s about three dozen studies were published. By the end of 2010, more than 250 studies were available compared to 2009, when Berg and Marques (2010) were only able to identify 190 studies. Past studies use cost or production functions to evaluate the performance of water utilities with several aims, such as examining the scale, scope or density economies of a particular country or region, determining the influence of ownership and other exogenous variables on efficiency (*e.g.* Renzetti and Dupont, 2009), investigating the extent and impact of incentive systems and alternative governance models, and assessing performance and identifying best practices. Most of these water utility benchmarking studies use parametric methods for efficiency estimation, although some apply non-parametric methods. Such studies have proven to be extremely useful in introducing yardstick competition, promoting cost containment, identifying efficient prices, and encouraging quality of service improvements in water utilities.

This study analyzes the literature concerning scale and scope economies. Inappropriate market structure (size distribution of utilities relative to the market size) jeopardizes the attainment of organizational efficiency and reduces the value for money in monopolized markets (Bel and Warner, 2008). Although governments intervene to curb the exercise of market power and correct market failures, through regulation or policies that promote competition, the presence of scale and scope economies suggests that customers require protection from monopoly pricing. Scale (or size) economies exist when an expansion in an output can be achieved with less than a proportionate increase in costs, whereas scope economies are present when the production costs of two or more products jointly produced are lower than when they are produced separately by two specialized entities (Baumol *et al.*, 1988). Thus, scale economies are related to the scale of production and scope economies to the savings arising from the joint production of goods or services.

There is no consensus in the literature regarding the (1) optimal scale of water utilities, (2) existence of scope economies between different types of services (e.g. water and wastewater services), (3) extent of economies of vertical integration (scope economies between the various stages of the production chain). Some empirical studies find scale and scope economies; the existence of (short run) high fixed costs in the water sector may reflect sharing of administrative and procurement costs. However, others find diseconomies and explain the higher costs due to the network complexity, and the bureaucracies associated with large utilities (Abbott and Cohen, 2009).

Perhaps because of these ambiguities (and unique circumstances related to water resource access, national income differences, and different legal systems), quite distinct water utility arrangements and different results between studies can be found around the world. Even in a single nation, suppliers can range from very small water utilities providing services to small villages to large utilities providing services to many customers in a large municipality or a region. Moreover, in some countries the drinking water supply is provided as a single service (e.g. the Netherlands); in others it is provided together with wastewater (e.g. France) and also with other services, such as urban waste, electricity or gas (e.g. Germany). There are also vertically integrated water utilities that are responsible for the wholesale and retail (distribution) segments (e.g. Spain), and others that deal with the wholesale or retail segments separately (e.g. Portugal). Table 1 presents the market structure in Europe. No clear patterns are observed in terms of size of scale and scope services. Developing countries have a similar range of institutional arrangements.

Figure 1 shows the growth of studies examining scale and scope economies, with the number published each year shown on the vertical axis. These past studies provide the "raw material" for the meta-regression analysis presented in the current study.

Table 1 – Market structure in the Europe

Country	Water utilities (no.)	Average population (no./utility)	Scope of services	Vertical Integration
Austria	5,000	1,640	Water and wastewater	Integrated
Belgium	28	375,000	Water and wastewater	Mostly unbundled
Czech Republic	1,211	8,505	Water and wastewater	Integrated
Denmark	2,622	2,059	Water and wastewater (two multiutilities)	Integrated
England and Wales	25	2,148,000	Water and wastewater	Integrated
Finland	1,400	3,786	Water and wastewater	Integrated
France	19,300	3,337	Water and wastewater	Integrated
Germany	6,000	13,667	Multiutilities and water and wastewater separated	Integrated
Greece	1,000	11,000	Water and wastewater	Mostly integrated
Holland	10 (water)	1,650,000	Water	Unbundled
	443 (collection)	660	Wastewater	
	25 (sewage treatment)	37,246	Wastewater	
Ireland	3,051	1,409	Water and wastewater	Mostly integrated
Italy	91	648,352	Water and wastewater	Integrated
Luxembourg	106	4,528	Water and wastewater	Mostly integrated
Northern Ireland	1	1,700,000	Water and wastewater	Integrated
Norway	1,616	2,908	Water and wastewater and other municipal activities	Integrated
Portugal	300	31,278	Water and wastewater and sometimes other activities	Mostly unbundled
Romania	2,000	7,700	Water, wastewater and urban waste	Unbundled
Scotland	1	5,100,000	Water and wastewater	Mostly integrated
Spain	8,100	5,556	Water and wastewater	Mostly integrated
Sweden	294	30,612	Water and wastewater. There are 5 multiutilities	Integrated
Switzerland	3,000	2,467	Multiutilities	Integrated

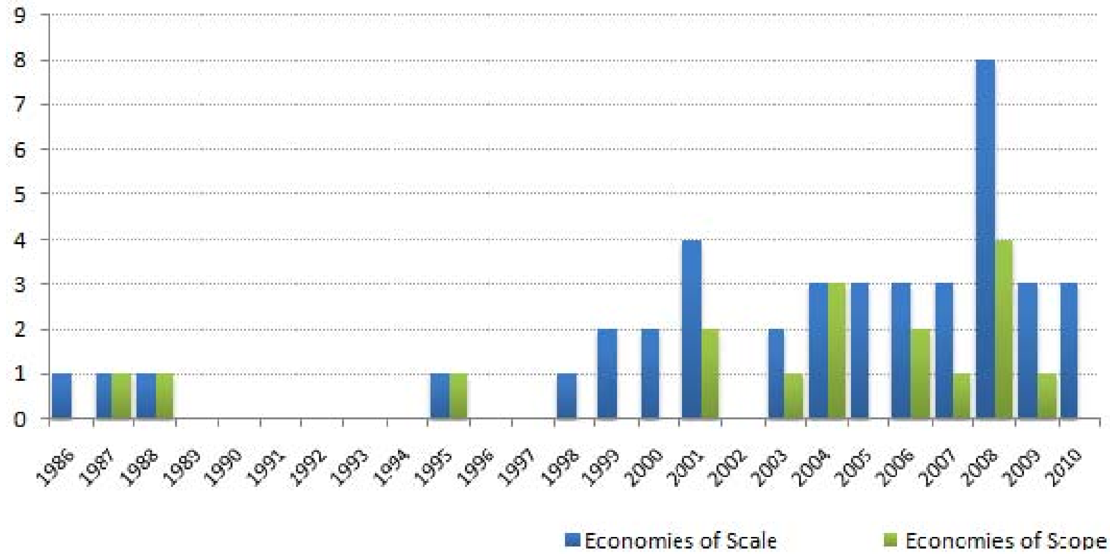

Figure 1- Studies of scale and scope economies per year

After briefly surveying previously published benchmarking studies about scale and scope economies, the current research investigates, by means of a meta-regression analysis, which variables or characteristics of samples from published studies have the greatest influence on estimated size of scale and scope economies. The sample encompasses all the benchmarking studies (published and unpublished) dealing with performance scores based on production or cost estimates. The sample comprises all the articles published in academic journals in the following fields: Economics, Public Policy, Public Administration, Political Science and Environmental and Water Policy. The sample also includes articles in edited books, chapters of books, PhD dissertations and in working paper series, including those in Policy Research Working Paper Series or Social Science Research Network. Section 2 presents lessons reported in the literature, followed by Section 3 which introduces the meta-regression analysis, the key concepts (on economies of scale and scope), and explains the variables utilized in the study. Section 4 presents and discusses the results; concluding observations are outlined in Section 5.

2. LESSONS FROM LITERATURE: A SHORT SURVEY

Ford and Warford (1969) were among the first authors to investigate scale economies in the water sector. They tried to identify an appropriate specification of the cost function for water utilities in the UK and argued that amalgamation of firms would not necessarily lead to a lowering of average costs. In the following two decades (70s and 80s), the literature focused primarily on issues of ownership, researching whether the type of ownership (public or private) influenced performance. The research is inconclusive regarding this issue. While some papers provided empirical evidence that publicly-owned water utilities have better performance (e.g. Bruggink, 1982), other studies concluded that private water utilities outperform the public ones (e.g. Crain and Zardkoohi, 1978); others did not find conclusive evidence that one ownership regime outperformed the other (e.g. Byrnes *et al*., 1986). Of course, model specification differed across these early studies; in addition, controlling for different governance (and incentive) systems was difficult due to inadequate data.

Some studies about scale and scope economies in the water sector were found in our census of studies, but all refer to the US and the UK. For example, Knapp (1978) reported strong economies of scale in the wastewater treatment in England and Wales. Fox and Hofler (1985) observed economies of scale in water distribution and diseconomies of scale in the production of water in the US. Kim (1987), in a study of US utilities, did not find significant economies of scale in drinking water supply, but found some economies of scale for non-residential water supply and some diseconomies of scale for residential water supply. During this period (70s and 80s), the first studies examining scope economies appeared. For instance, Hayes (1987) observed economies of scope in the US for small, vertically integrated companies, but not for the large ones. In another US study, Kim and Clark (1988) detected scope economies for joint production of residential and non-residential water supply.

In the two decades that followed (the 1990s and 2000s) the number of benchmarking studies published about water sector cost and production functions more than doubled. However, there was still no consensus regarding optimal size of water utilities or the extent of scope economies (Abbott and Cohen, 2009). For example, Ashton (1999), among others, found economies of scale in the UK, but Saal and Parker (2000) and other authors obtained opposite results. Subsequently, a study from Stone and Webster (2004) concluded that the biggest companies in England and Wales (water and wastewater companies) presented diseconomies of scale and the remaining small water-only companies displayed economies of scale. Later Saal and Parker (2004) found constant returns to scale and Saal *et al*. (2007)

revisited the issue, finding that large water and sewerage utilities are characterized by diseconomies of scale in England and Wales.

For the US, as in the two previous decades, strong economies of scale were found (Bhattacharya *et al*., 1994; Shih *et al*. 2006). However, Torres and Morrison Paul (2006) observed economies of scale for small utilities but diseconomies of scale for the largest utilities. Similar results were obtained for other countries, including Italy (Fabbri and Fraquelli, 2000; Fraquelli and Giandrone, 2003; and Fraquelli and Moiso, 2005), France (Garcia and Thomas, 2001), Japan (Mizutani and Urakami, 2001), South Korea (Kim and Lee, 1998) and South Africa (Tsegai *et al*., 2009). Recently, Nauges and van den Berg (2008) found economies of scale in Colombia, Moldova and Vietnam for small and medium utilities but not in Brazil. In other countries, such as Portugal (Correia and Marques, 2010; and Martins *et al*., 2006), Germany (Sauer, 2005), in Latin America (Ferro *et al*., 2010), Peru (Corton, 2010), Spain (Prieto *et al.*, 2009) and Canada (Renzetti, 1999), most studies found economies of scale in providing water services. However, for Switzerland, Baranzini and Faust (2009) found diseconomies of scale for multi-utilities. The Appendix lists the studies estimating economies of scale that made up the sample utilized in the current study.

Regarding research on economies of scope, again results in the literature are mixed. Of the studies examining scope economies between water and wastewater services, a large proportion find scope economies (e.g. Fraquelli *et al*., 2004, Lynk, 1993; Hunt and Lynk, 1995; Fraquelli and Moiso, 2005 and Martins *et al*., 2006), although some analysts conclude that the savings are greater for small companies than for large ones. However, other studies concluded just the opposite (Saal and Parker, 2000 and Stone and Webster, 2004). For example, the study by Stone and Webster Consultants reports that in England and Wales no scope economies exist between water and wastewater. Also, Correia and Marques (2010) observed decreasing economies of scope in Portugal. Similarly, Prieto *et al.* (2009) found no evidence of statistically significant scope economies in Spain.

Apart from the activities of water supply and wastewater collection, the comprehensive sample identified studies quantifying economies of scope between other activities in multi-utilities, such as electricity, urban waste or gas services. For example, Fraquelli *et al.* (2004) and Piacenza and Vannoni (2004) found significant scope economies for multi-utilities in Italy. Other studies investigated scope economies associated with vertical integration and suggest the existence of scope economies in joint retail and wholesale segments, especially for the smallest water utilities (Hayes, 1987). For example, Stone and Webster Consultants (2004) observed benefits in vertical integration in the water supply in England and Wales; Torres and Morrison Paul (2006) reached the same conclusions for the water sector in the US. Urakami (2007) examined the Japanese water supply industry and noted the existence of economies of vertical integration between water intake-purification and the water distribution stage. In contrast, Garcia *et al.* (2007), using a sample of US utilities, concluded that separation maybe advantageous in some circumstances, and that economies of vertical integration are not significant except for the smallest utilities. Appendix 2 lists all the studies found in the literature that empirically examined economies of scope.

Although there is no consensus in the literature regarding the optimal size of water utilities or the existence of economies of scope among various activities, it is generally agreed that small water utilities providing only one service or that are not vertically integrated have significant scale and scope economies that seldom are achieved due to relatively low levels of output; large or vertically integrated utilities seem to have scale and scope diseconomies at the levels of output they produce. The literature reports a wide range of a maximum number of connections where economies of scale were not exhausted. For example, Fraquelli and Giandrone (2003) found values of 100,000 in Italy, while Mizutani and Urakami (2001) found 766,000 (in Japan) and Fraquelli and Moiso (2005) estimated the leveling off point at one million for Italy. There is less divergence of views in relation to wastewater activities, in part because these activities have been subject to less research or have been examined in the context of businesses undertaking both water supply and wastewater activities (e.g. Ashton, 2000). Both Knapp (1978) and Renzetti (1999), who are exceptions, found that economies of scale exist in the wastewater sector. The results reported in the literature are more consistent with regard to economies of density and, in general, the studies point to both their existence and to their importance (Antonioli and Fillipini, 2001; Zoric, 2006).

These findings are not surprising, given differences between the geographic, hydrologic, topographic circumstances in different countries or regions or to, differences in ownership, degree of corporatization, and to the legal framework for providing the activities of the water sector (including the existence, or absence, of regulatory or ministerial oversight). Also density, customer income levels, distance from water sources, and a variety of other factors may (or may not) have been adequately controlled for in particular studies. However, to a certain extent it is clear that there are savings from the use of shared resources and from reduced administrative and procurement costs per customer; the issue is whether such economies outweigh the greater costs associated with network complexity, and possibly the bureaucracy accompanying the increase in the size of the utility. The literature is also inconclusive as far as the issue of ownership is concerned. Recently Bel *et al.* (2010) conducted a meta-regression analysis examining privately-owned and publically-owned water distribution services with a sample of twenty-seven studies; they found no systematic support for lower costs with private production. They did not investigate the extent of economies of scale and scope, so it is useful to apply the technique to this technical question.

3. META-REGRESSION ANALYSIS

Narrative literature reviews generally identify all the available studies, listing conclusions for each one. However, such an approach does not consider model specification, number of observations, and other factors affecting the quality of the studies, so the conclusions from such surveys tend to be impressionistic rather than definitive. This problem can be mitigated by applying a meta-regression analysis. This technique combines the results of several studies that address a particular research topic and, through statistical methods, tries to find the true relationship between different variables and the results reported in the different studies (Stanley and Jarrell, 1989). The present study examines the influence of several variables on the results found in benchmarking studies that address the issue of scale and scope economies in the water services sector.

According to Stanley and Jarrell (1989) a meta-regression analysis can be performed using the following model:

$$b_j = \beta + \sum_{k=1}^{K} \alpha_k Z_{jk} + e_j \quad (j = 1, 2, ..., L) \tag{1}$$

where b_j is the reported estimate of β of the j^{th} study of the literature consisting of L studies, β is the "true" value of the parameter under examination, Z_{jk} are the meta-independent variables that measure relevant characteristics of an empirical study, and α_k are the coefficients related to these independent variables which reflect the systematic biasing effect of particular characteristics studied, and e_j is the meta-regression disturbance term.

In this study we apply a random effects meta-analysis that estimates the extent to which several covariates explain heterogeneity in the dependent variables (in this case, scale and scope economies) between studies. For this purpose, a weighted normal-error regression model was performed in which an additive between study variance component τ^2 is estimated. First the maximum-likelihood estimates of the α_k parameters assuming $\hat{\tau}^2 = 0$ are obtained by weighted regression, and then a moment estimator of τ^2 is calculated using the residual sum of squares (Sharp, 1998).

For situations where the number of studies is particularly small, it is advisable to apply an additional test (permutation test), to obtain better results with respect to the p-values associated with independent variables. Permutation tests provide a nonparametric way of simulating data (by Monte Carlo simulation) under the null hypothesis (Harbord and Higgins, 2008).

The statistical significance of the coefficients associated with the independent variables will allow us to examine the influence of this variable on the dependent variable. This meta-regression analysis considers as dependent variable b_j, the corresponding values of estimated overall (or aggregate) scale economies (SL) and the degree of economies of scope (SC) obtained by the studies in the sample (here, a sample that approaches a census).

According to Baumol (1976) and Panzar and Willig (1977) the degree of scale economies (SL) for the multi-product water utility is defined as:

$$SL(y) = \frac{C(y)}{\sum_i y_i MC_i} = \frac{1}{\sum_i \varepsilon_{Cyi}} \tag{2}$$

where C is the total cost of producing outputs y, MC_i is the marginal cost with respect to the i^{th} output and $\varepsilon_{Cyi} = \partial \ln C / \partial \ln y_i$ is the cost elasticity of the i^{th} output. The existence of (dis)economies of scale is assessed according to whether $SL(y)$ is greater than, equal to, or less than unity. If $SL>1$ the water utility operates with economies of scale (or size); if $SL<1$ the water utility operates with diseconomies of scale. If, on the other hand, $SL=1$, that means that the water utility operates at constant returns to scale.

Moreover, economies of scope are related to the fact that joint production costs are lower than the sum of the production costs for separate specialized water utilities, and the degree of economies of scope (SC) is defined by:

$$SC = \frac{\sum_{i=1}^{n} C(y_{n-i}) - C(y)}{C(y)} \tag{3}$$

where $C(y_{n-i}) = C(y_1, ..., y_{i-1}, 0, y_{i+1}, ..., y_n)$.

Herein, if $SC>0$ the water utility faces economies of scope and if $SC<0$ the water utility presents diseconomies of scope.

The meta-regression analysis utilized Stata software. The model included the following variables for each study: sample size (number of water utilities analyzed), year of publication, number of years studied, the GDP of the country, the continent where the utilities are located, the estimation method used in the study, the type of utilities involved (whether or not they are multi-utilities), publication type of the study, the average size of utilities, the primary ownership-type for firms in the study sample and the existence (or nonexistence) of regulation. A positive sign of the coefficient α_k indicates that the corresponding explanatory variable tends to be larger, thus increasing the reported scale or the scope economies; if the coefficient presents a negative sign, it means that the explanatory variable tends to negatively affect estimated scale or scope economies.

The variable GDP of the country took on the values of Gross Domestic Product (GDP) reported for 2009. This variable reflects the country's standard of living. The variable

Continent is a dummy variable with assigned values from 1 to 5: 1 corresponds to the Continent with the highest GDP (United States/Canada) and 5 to the Continent with lowest GDP (Africa). The value 2 was assigned to Europe, 3 to Asia, and 4 to South America/Central America. The meta-regression included the estimation method used in the studies, the type of utilities involved (whether they were multi-utilities, value 1, or not, value 0) and the publication type of the study. Each of the variables captures differences in the studies. For the estimation method, the dummy variable takes on the value 1 for studies that apply several estimation methods and takes on the value 0 for studies that apply only one estimation method. The estimation methods observed in the literature included Ordinary Least Squares (OLS), Seemingly Unrelated Regression (SUR), Nonlinear Seemingly Unrelated Regression (NLSUR), Maximum Likelihood Estimation (MLE), Generalized Method of Moments (GMM) and Restricted Least Squares (RLS). When each variable was tested separately, the coefficients lacked statistical significance, so the final model does not consider them individually. The dummy variable for publication type takes the value 1 for Theses and Journals and the value 0 for Reports, Chapters and Working Papers). Since Theses and Journal articles must pass more rigorous reviews, the sign on this coefficient provides an indication of whether economies are more likely to be found in more technically-refined empirical analyses. Furthermore, we examined the influence of the average size of utilities (represented by the amount of water billed in cubic meters), the influence of ownership (if mostly public, value 1, or mostly private, value 0) and the existence or nonexistence of regulation (if there is a sector specific regulator, value 1, or if not, value 0). Although monopoly utilities generally face some type of oversight—even if by locally elected officials or a water ministry, this variable is intended to capture the impact of more formal national regulation.

4. RESULTS AND DISCUSSION

Since in this case-study samples are small, we applied the permutation test, which has supports the results presented in Table 2. Table 3 provides the p-values associated with each independent variable. In the first column there are the permutation p-values without an adjustment for multiplicity, which are similar to those obtained without using the permutation test, and in the second column we find the p-values adjusted for multiplicity.

Table 2 – Meta-regression estimates

	Dependent variable: estimates of scale economies (SL)		Dependent variable: estimates of scope economies (SC)	
Variables	Coefficient	Standard errors	Coefficient	Standard errors
Sample size (No. of water utilities analyzed)	0.000030	0.00010	-0.00011	0.00012
Year of Publication	0.002	0.012	0.018	0.008
No. of years studied	0.0012	0.0084	0.03	0.047
GDP of country	$-3.46e^{-8}$**	$1.41e^{-8}$	$3.53e^{-9}$	$1.73e^{-8}$
Continent	-0.096	0.065	0.0037	0.13
Estimation method	-0.20*	0.10	-0.29	0.22
Type of utilities	0.031	0.098	0.030	0.18
Publication Type	-0.095	0.093	-0.23	0.22
Average size of utilities	$-1.12e^{-9}$*	$8.55e^{-10}$	$-2.69e^{-9}$	$1.92e^{-9}$
Ownership	-0.018	0.13	-0.068	0.24
Regulation	0.07	0.17	0.49	0.44
Intercept	1.65	0.25	0.39	0.40
R^2	0.177		0.170	
Joint test for all covariates With Knapp-Hartung modification	F(9.25)=1.65 Prob > F = 0.1543		F(9.3)=1.19 Prob > F = 0.4932	
N	35		13	

*** - significant at the 1 percent level, ** - significant at the 5 percent level,
* - significant at the 10 percent level

Table 3 – p-values associated with each independent variable using the permutation test

	Dependent variable: estimates of scale economies (SL)		Dependent variable: estimates of scope economies (SC)	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Sample size (No. of water utilities analyzed)	0.698	1.000	0.260	0.657
Year of Publication	0.927	1.000	0.130	0.446
No. of years studied	0.940	1.000	0.731	0.990
GDP of country	0.024	0.203	0.646	0.970
Continent	0.143	0.692	0.552	0.928
Estimation method	0.063	0.418	0.152	0.262
Type of utilities	0.930	1.000	0.541	0.921
Publication Type	0.379	0.971	0.980	1.000
Average size of utilities	0.083	0.779	0.396	0.812
Ownership	0.901	1.000	0.956	1.000
Regulation	0.671	1.000	0.562	0.934

Regarding the economies of scale, the results indicate that the coefficient of the variable sample size (number of utilities analyzed) is positive. This means that when the sample size is greater, economies of scale are more likely to be found. Although the value of this coefficient is not statistically significant to a confidence level of 95%, we would expect a relationship since, in general, the samples are composed of many utilities which are generally smaller; thus, there is greater potential for scale economies. After adjusting for multiple testing, there remains some weak evidence that the number of utilities analyzed has influence on the degree of economies of scale. The adjusted p-value of 1.000 gives the probability under the null hypothesis (that all regression coefficients are zero) of a T statistic for any of the covariates being as extreme as the one observed for the covariate "number of utilities analyzed." However, the opposite result is obtained for scope economies (although without statistical significance to a confidence level of 95%), which suggests that the samples with greater number of utilities are more likely to have diseconomies of scope.

A positive signal was determined for the year of publication both for scale and scope economies. It means that the most recent studies are more likely to find economies of scale and economies of scope. This can be related to some consolidation of the water sector market structure overtime or to the fact that early studies presumably used less sophisticated estimation techniques and simpler models (reflecting limited data availability). Nevertheless, the statistical significance of the results obtained is weak at a confidence level of 95%.

The coefficient for the variable "number of years studied" has a positive sign for both cases. This means that studies that analyze a greater number of years are more likely to find scale and scope economies. However, again, these coefficients are not statistically significant at a confidence level of 95%. The coefficient for country GDP has a negative sign and it is statistically significant for the case of scale economies at a confidence level of 95%. This result suggests that countries with higher GDP are more likely to exhibit diseconomies of scale. This finding also indicates that in countries where the standard of living is lower, there are probably many utilities with significant economies of scale to be exploited. That point is corroborated by the negative value of the coefficient of the variable Continent, corresponding to the higher value of GDP to the lowest value of this explanatory variable. Yet, for the case of economies of scope, the coefficients of the variables GDP and Continent have a positive value. This result indicates that despite not being statistically significant, there could be a greater probability of finding scope economies in more developed countries. Since few of these studies include service quality as an output, the role of GDP is mixed. Developed countries tend to meet World Health Organization standards for water quality and the treatment levels for wastewater meet strict standards. Neither is the case for low income nations so that interpreting the role of income levels on estimated economies of scale and scope is not simple.

Clearly, the application of more sophisticated estimation techniques leads to improved modeling. How do results from studies using single estimation techniques differ from those employing multiple approaches? For the estimation method adopted, the corresponding coefficient is negative for both cases, but only statistically significant to a confidence level of 90% for the case of scale economies. This means that studies that apply multiple estimation methods have a higher probability of finding scale and scope diseconomies.

Regarding the type of utilities studied, it seems that the corresponding coefficient is positive for both cases, which means that multi-utilities are more likely to have scale and scope economies. Finding economies of scope is more likely in multi-utilities between different types of services (e.g. water and wastewater services) than finding economies of vertical integration in the utilities that provide only one service. This reflects typical results found in the literature, although, again, without statistical significance at a 95% confidence level.

As for the type of publication, the corresponding coefficient is negative for both cases, but (again) without statistical significance at a confidence level of 95%. It seems that scale and scope diseconomies are more likely to be found in studies published in Theses and Journals. In their examination of the impact of privatized production, Bel *et. al.* (2010) concluded that there is a publication bias related to privatization studies: “papers obtaining significant cost savings are more likely to be published” (p. 573). However, one could argue that unpublished papers have not passed the hurdle of critical external reviews, so the differences in results could be a reflection of reality rather than some presumed investigator bias. In the case of the results reported here, there is no reason to think that there is a systematic journal acceptance bias in favor of studies that find scale and scope diseconomies.

The variable average size of utilities has a negative sign for both cases, but it is only statistically significant at a of 90% confidence level for the case of scale economies. This supports typical findings in the literature: there is a higher probability of finding diseconomies of scale and scope when the sample involves large utilities.

As to the ownership variable ownership, the coefficient is negative for both cases. This suggests that publicly-owned utilities are more likely to display scale and scope diseconomies. Although the value of this coefficient is not statistically significant at a confidence level of 95% for either case, this statement is consistent with private utilities enjoying greater scale and scope economies. This result contrasts with the meta-regression study by Bel et. al. (2010) which finds no empirical evidence of cost savings from private provision of water distribution. One explanation may be that given the prevalence of state-owned enterprises in water (including municipal ownership), there is some endogeneity in the decision to privatize: utilities with scale and scope economies are more likely to be privatized.

Finally, regarding the regulation variable, the coefficient is positive for both cases but not statistically significant at a confidence level of 95%. This result provides some support for regulated environments being associated with utilities having scale and scope economies.

5. CONCLUSIONS

The analysis yields some interesting conclusions that have not been emphasized in the quantitative literature on water sector economies of scale and scope. The results show that there is a higher probability of finding diseconomies of scale and scope in large utilities, although statistical significance was only found for scale diseconomies. In addition, countries with higher GDP are more likely to have utilities that exhibit (statistically significant) diseconomies of scale, while the opposite pattern appears for economies of scope.

Although not statistically significant, publicly owned utilities are more likely to have scale and scope diseconomies than when the ownership is mostly private. In addition, multi-utilities are more likely to exhibit scale and scope economies. These patterns suggest that, based on empirical results reported in the literature, economies of scope in multi-utilities are more pronounced between different types of services (e.g. water and wastewater services) than economies of vertical integration in the utilities that provide only one service.

Finding definitive results in meta-regression analysis requires that all the factors characterizing individual studies be included in the model. Furthermore, the linearity of the model (assumed in most analyses of multiple regression-based econometric studies) ignores possible non-linearity in the relationships among the explanatory variables. Nevertheless, periodic examination of empirical studies provides a systematic check on results to date. As new databases become available, and additional variables are included in cost and production function models, our understanding of causal links between inputs and outputs improves. Here, the focus has been on economies of scale and scope, topics that are central to decisions to consolidate current operators or to decentralize operations. However, the decision-relevance of the scholarly literature is still an open question. Is it obvious that a utility operating in a region of diseconomies of scale should be split up, as in the case of Manila? Were the resulting performance gains in Manila due to the availability of yardstick comparisons, privatization, or to achieving an "optimal" size? Should two separate organizations be maintained for water and wastewater when a coefficient of a study suggests that economies of scope are being missed? Although few would argue against "evidence-based" decision-making, the weight given to facts is unlikely to be the deciding factor for those responsible for water sector policies.

An interview with John Briscoe (2011) identifies the disconnect between national policy-makers, advocates, international civil servants and researchers as creating lost opportunities. He sees the need for water policy to recognize that a broader set of social challenges warrant our attention and that the timing of dramatic initiatives seldom depends on empirical studies. Briscoe concludes his interview with some words of wisdom:

> So I see a great challenge in building a new water intelligencia, one which has learned that there is a big difference between idea and practice, but one which seeks to bring new ideas – but ideas which will work – to address this generation of challenges. And one which communicates far better than the practical water communities today manage to do! . . . We have to learn that political capital is limited, and challenges are many. The great advances are made in those special moments when political possibility aligns with our agenda. We have to learn to strike when that iron is hot (and not keep thinking that we are the ones who will heat the iron!).

Thus, quantitative studies of water and wastewater utilities can identify opportunities for aggregation and disaggregation: they can help establish a policy agenda. However, political factors will continue to play a dominant role in policy-decisions related to economies of scale and scope.

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