Economies of Scale in Local Government Services: A Meta Analysis

Siew King Ting[1], Rene Villano[2] and Brian Dollery[3]
[1]Faculty of Management and Business,
Universiti Teknologi MARA Cawangan Sarawak, Malaysia
[2,3]UNE Business School, University of New England,
Armidale NSW 2351, Australia

[1]tings036@sarawak.uitm.edu.my; [2]rvillan2@une.edu.au; [3]bdollery@une.edu.au

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ABSTRACT

In this paper, a meta-regression analysis is presented by 38 empirical studies on the size of scale in various local government services. Our results show that income classification was the most important factor in determining size of scale and all selected local government services recorded decreasing size of scale in the recent decades, with water services exhibiting the largest decreasing size of scale. The existence of scale effects has important ramifications for local government structural reform, given the globally indifferent results of local government reorganization.

Keywords: *Meta regression; economies of scale; local government services; transport services, water services.*

INTRODUCTION

Local government reorganization through council consolidation and other kinds of structural change is often justified on economic grounds in general and scale economies in particular. The twin claims that 'bigger is better' and 'bigger is cheaper' in local government typically assuming that municipal service provision is characterized by economies of scale. Councils with larger populations are presumed to enjoy significant benefits from scale economies, including increased labour specialization, greater purchasing power, lower production costs and smaller administrative overheads. These assumptions are used *inter alia* to justify efforts to increase the population size of local authorities through municipal mergers (Dollery, Bligh & Kortt, 2012).

However, quite apart from concerns surrounding the ubiquity of scale economies in municipal service provision, these claims clash with empirical evidence on the various problems associated with structural reorganization, such as prolonged low morale among employees (Durning & Nobbie, 2000), high transition costs (Chisholm, 2010), mixed results on the net success of amalgamation (Vojnovic, 2000; Reese, 2004), problems with ongoing service delivery (Cameron, 2005), opportunistic political behaviour (Hinnerich, 2009), residential segregation (Dawkins, 2005) and higher local public expenditure (Hanes, 2014). In recent years, researchers also explored the potential of economies of scale at the corporate level of local government to induce cost savings (Ting, Dollery & Villano, 2014; 2017(a)). In short, local government reorganization is highly controversial (Pemberton, 2016).

A substantial scholarly literature exists on scale economies in municipal service provision (see, for instance, Boyne (1995), Byrnes and Dollery (2002), Copus, Crowe and Clark (2005), Gomez-Reino (2010), Carvalho, Marques and Berg (2012), Dollery et al. (2012) and Callanan, Murphy and Quinlivan (2014) for reviews of the literature). These surveys of the empirical literature typically find inconclusive and often inconsistent evidence of scale economies in various types of local government services in different countries. In particular, some reviews of the literature have revealed inconsistencies in measuring scale and different methodologies deployed, with considerable controversy on the merits of alternative methodologies and functional forms and their impact on empirical results. Notwithstanding these problems, empirical work on scale in local government service provision proceeds apace.

In contrary to this background, the main aim of this paper is to examine the impact of various attributes of empirical studies on their findings on scale in local government service provision. This paper does not aim to reach a conclusion on the optimal scale of various local government services, given differences in production technology in services within and across the countries. In other words, the paper examines the characteristics of production technology that determine the scale elasticity in local government services using existing empirical studies.

In order to accomplish this objective, a meta-regression analysis of 38 empirical papers on scale in local government service provision is undertaken. In essence, meta-regression analysis is a quantitative method used to evaluate the effects of a set of explanatory variables, including methodology and other study-specific characteristics, on empirical findings on the magnitude of scale in a regression model (Borenstein, Hedges, Higgins & Rothstein, 2009).

The paper is divided into five main parts. Section 2 elucidates the concept of economics of scale, followed by a brief review of scale effects in local government services in Section 3. Section 4 describes the data sources and methodology employed in the study. Section 5 discusses the results. The paper ends in section 6 with a summary of its main findings, along with some suggestions for further research.

ECONOMIES OF SCALE

Local authorities are typically multi-functional public organizations which provide a range of different services, such as local roads, water, waste management and leisure facilities, to the local residents. The production of these services requires different combinations of inputs, like land, labour, capital and materials, to be applied to a technological process which produces goods or services. In general, economists use production functions, which specify technical relationships between quantifiable inputs and outputs, in order to determine the properties of production processes. Thus, economists create a classification of different ranges of generic production characteristics which can be measured in terms of returns of scale.

In general, scale economies are defined by the inverse of the elasticity of cost with respect to output (i.e. ratio between marginal and average cost) (Baumol, Panzar & Willig, 1982). Berechman (1984) and Obeng (1985) defined scale economies as one minus the sum of the cost elasticities.

Some researchers further divide scale measures into short-run and long-run economies of scale (Cambini, Piacenza & Vannoni, 2007; Fraquelli, Piacenza & Vannomi, 2004).

Following the pioneering work of Baumol et al. (1982), two types of scale measures have been employed: overall and product-specific scale economies (SL). Overall scale economies are defined as:

$$SL(Y,P) = \frac{C(Y,P)}{\sum_i Y_i MC_i} = \frac{1}{\sum_i \varepsilon_{CY_i}} \quad (1)$$

where $MC_i = \partial C(Y,P)/\partial Y_i$ is the marginal cost; $\varepsilon_{CY_i} = \partial \ln C(Y,P)/\partial \ln Y_i$ is the cost elasticity with respect to the ith output; $C = C(Y,P)$ is the multi-product cost function, with $Y =$ outputs and $P =$ input prices. Product-specific economies of scale for the couple of products $(i, j; i \neq j)$ are defined as:

$$SL_{ij}(Y,P) = \frac{IC_{ij}}{Y_i MC_i + Y_j MC_j} = \frac{IC_{ij}}{\left[\varepsilon_{CY_i} + \varepsilon_{CY_j}\right] C(Y,P)} \quad (2)$$

where $IC_{ij} = C(Y,P) - C(Y_{-ij}, P)$ represents the incremental cost of the couple (i, j) and $C(Y_{\_ij}, P)$ is the cost of producing all the other products different from i and j. Scale economies specific to some product i are defined as:

$$SL_i(Y,P) = \frac{IC_i}{Y_i MC_i} = \frac{IC_i}{\varepsilon_{CY_i} C(Y,P)} \quad (3)$$

where $IC_i = C(Y,P) - C(Y_{-i}; P)$ is the incremental cost relating to the ith product and $C(Y_{-i}, P)$ is the cost of producing all outputs except the ith one.

The returns to scale defined by equations (1), (2), and (3) are said to be increasing, constant or decreasing as $SL(Y,P), SL_{ii}(Y,P)$ and $SL_i(Y,P)$ are greater than, equal to, or less than unity, respectively. Based on these equations, returns of scale thus, are categorized into economies of scale (EOS = >1), constant economies of scale (COS = 1) and diseconomies of scale (DOS = <1). EOS occurs when the average costs decrease as output increases, COS exists if the change in average costs are equal to change in outputs, and DOS manifests when the average costs increase as output increases. EOS arises mainly from labour specialization and the bulk purchases of raw material, whereas DOS stem from managerial complexities and communication breakdown, among other factors.

From a policy perspective, different average cost curves yield different strategies for local government restructuring (Ting et al, 2014; Andrews & Boyne, 2009): economies of scale suggest the centralization of municipal services; diseconomies of scale indicate decentralization of local government services to induce cost savings; non-linear U-shaped cost functions buttress intermediate-sized local government; and finally non-linear inverted U-shaped suggest either small or big local councils.

SCALE EFFECTS IN LOCAL GOVERNMENT SERVICES

The services provided by local authorities vary greatly between countries. Furthermore, there is significant variation in the magnitude of scale economies in local government services, as we have seen. Differences in the estimated magnitudes of scale economies may arise from different methodological characteristics, such as output indicators, cost measurement, estimation techniques, functional forms, type of data, size of samples and countries, among other factors. We now briefly consider fundamental methodological features employed in the empirical literature concerned with examining scale economies in local government services.

Various definitions of size of scale have been advanced. In general, the size of scale is indicated by the outputs of local government services and measured as scale elasticity (the inverse of the elasticity of cost with respect to output). The choice of output indicator remains unsettled in determining scale in local government services. Output is often proxied by either population size or physical output. The use of population as a proxy of output is common in aggregated services offered by local councils (Ting et al., 2014; Drew, Kortt & Dollery, 2014; Bikker & Linde, 2016; Matejova, Nemec, Krapek & Klimovsky, 2017) given the complex nature of multifunctional local government and the constraint of data availability. However, the use of population size as an output indicator is contested: Boyne (1995), Byrnes and Dollery (2002) and other scholars have argued that population is not an output. It has been argued that the use of aggregated outputs, such as population size, as a measure of product-specific scale economies will bias its estimate of scale (Bel & Mur, 2009; Geys, Heinemann & Kalb, 2007). In general, the use of population is less common in output-specific services, such as transport, water utilities and waste management.

The choice and number of physical outputs are not uniform within the same type of service. Researchers often use different types of output to measure scale. For instance, in transport studies, empirical scholars use supply-orientated outputs, like seat-kilometers, to measure the change in total cost with respect to output capacity kilometers (Cambini et al., 2007), and demand-orientated outputs, such as passenger-trips or passenger-kilometers, to measure the change in total cost with respect to utilization of capacity (Jha & Singh, 2001). Much the same goes for waste collection studies where choices of outputs include waste collection (Bel & Fageda, 2009), population (Bel & Mur, 2009), and the number of pick-up points (Dijkgraaf & Gradus, 2003). In terms of the number of outputs, scholars customarily use one output and some employ up to three outputs which are output-related characters or hedonic variables, like network, number of customers, and area to determine size of scale. The problem of separability arising from the nature of interdependencies between different sub-stages of production (Sauer, 2003), particularly in water and waste utilities, has further complicated the measurement of size of scale. These problems have generated different estimates of scale in local government service provision.

Scholars have used different functional forms to measure the cost structures of local council services. The main forms used in the literature include translog, linear, log-linear and quadratic specifications. The translog specification is the most common flexible functional form used in specific-output services. The translog form is a local, second-order approximation to an arbitrary cost function. This form places no *a priori* restriction on the elasticity of substitution and allows the economies of scale to vary with output (Cambini et al., 2007). On the other hand, linear functions are restrictive and scale measurement is constant regardless of output levels (Urakami & Parker, 2011). Although frequently used in the empirical literature, the translog form is constrained by several assumptions, such as cost minimization, homogeneity of product, loss of degree of freedom resulting from interactive terms, and omitted factors, which may bias empirical results.

Besides employing varying functional forms, econometric models are often different, and include seemingly unrelated regression (SUR), ordinary least squares (OLS), generalised least squares (GLS), maximum likelihood (ML), general method of moments (GMM) and stochastic frontier analysis (SFA). The SUR method is most widely used, particularly in transport and water utility studies. SUR is a generalized least squares estimation procedure and can be used to estimate the cost shares and cost function simultaneously, and improve the quality of the estimators (Roy & Croissant, 2008). Wooldridge (2009), Kumbhakar and Lovell (2000), and other scholars have outlined the strengths and weaknesses of these methods.

Variation of measurement of unit cost also characterizes the local government scale effects literature. The dependent variable or cost function is generally proxied by various types of cost, such as total expenditure (Geys et al., 2007), total cost (Correia & Marques, 2011), and variable cost (Nauges & Berg, 2008), among others. Accordingly, researchers must operationalize three concepts: (a) level of total output; (b) a discrete unit of output; and (c) cost of a unit of output, in order to measure scale effects correctly (Boyne, 1995). However, even when discrete parts of service output are available, problems remain, such as measuring the total output of a service and the summation different services into overall total output (Boyne, 1995). Empirical scholars typically do not decompose total expenditure or total costs. According to Byrnes and Dollery (2002), total expenditure should not be used as a measure of cost since it embraces substantial overhead and administrative expenses.

Most of the empirical studies have been conducted in OECD countries, with limited work undertaken in developing countries, across different types of services. Recent work has suggested that researchers prefer panel data to cross sectional data. Several literature reviews on local government services are noteworthy, including Roys and Croissant (2008) and Cambini et al. (2007) in transport; Walter, Cullmann, Hirschhausen, Wand and Zschille (2009), and Carvalho et al. (2012) in water utilities; Byrnes and Dollery (2002) in aggregated and specific local government services; and Bel and Warner (2008) in waste management.

There are thus, substantial differences in measuring scale effects in local government services, as identified in these literature reviews. Using econometric methods, researchers employed cost of production as a dependent variable, and a set of independent variables such as output and other production characteristics, to derive two main outcomes: (a) scale elasticity and (b) independent variables that influence the cost of production. In this paper, scale elasticity is used as dependent variable and production characteristics, as independent variables, in order to examine the production characteristics that influence the scale elasticity.

RESEARCH METHODS

Data Considerations

We focus exclusively on empirical studies which examined scale effects in the public sector, especially local government, using cost functional models (since economies of scale refers to the changes in cost due to the changes in output). Empirical studies which examine scale economies outside municipal services and use non-parametric approaches are thus, excluded from this analysis.

Data envelopment analysis (DEA) approach is excluded because it is non-parametric, non-stochastic and uses index number to measure scale effects. Deterministic frontier approach (DFA) is also left out from the review because it is non-stochastic and empirical studies that employ DFA is rare. We thus focus on empirical studies that employ parametric and stochastic methods, such as SUR, OLS, GLS, ML, GMM and SFA, that examine scale effects in local government services. These empirical studies examine scale economies by employing cost functional forms. Future researchers could conduct meta-regression analysis on empirical studies of scale economies in local government services that use DEA and DFA.

A thorough search was conducted by listing the keyword searches such as ‘size of scale’, ‘scale economies measurement’ and ‘municipal services’ in both public sector and local government literature in different academic databases. These databases consisted of Google Scholar, Ingenta, Science

Direct, Web of Knowledge, Springer Link, Social Science Citation Index, Scopus, and Academic Search.

Although new studies are published from time to time, we only selected studies from earlier 1980s to earlier 2000s, given that the worldwide modernization of local government key public services took place in those decades. Our literature search yielded a total of 38 published articles which included the type of information required for the present study. The selected studies were published from 1981 onwards until 2013. Given that many papers reported multiple estimates of scale effects, a scale effect based on mean output is recorded as an independent study, if there is a difference in approach, functional form, number of observations or dependent variable. As a result, the final dataset under analysis comprises a total of 84 estimations.

These empirical studies use a wide range of variables to measure size of scale. To simplify the analysis, we select the basic and common variables that were employed in these studies. The omitted variables could result in biased results (Mansson, 2007; Wooldridge, 2009). Nevertheless, these studies are sufficiently similar to derive results which can be interpreted meaningfully.

Following Gomez-Reino (2010) and Carvalho et al. (2012), we focus on the methodological characteristics as derived from the literature review. These features include: (a) methods, (b) functional forms, (c) types of data, (d) years of publication, (e) number of outputs, (f) income classifications, (g) types of services, and (h) scale elasticity. A brief summary of the sample is derived through descriptive statistics in order to describe the main features and or trend in size of scale by methodological characteristics.

Several statistical tests are then conducted on original data, as detailed below, prior to meta-regression analysis. Independent t-tests and one-way ANOVA tests are used to compare the mean size of scale, where the former is used to compare means between two groups, whereas the latter is employed when comparing more than two groups. Mann-Whitney U and Kruskal-Wallis tests are employed to compare median size of scale where the former is used to compare medians between two groups, whereas the latter is employed when comparing more than two groups.

Table 1: Scale Elasticities by Methodological Characteristics

Items	No of Etudies	Scale Elasticities				
		Mean	Median	Max.	Min.	Std. Dev.
Approaches						
Ordinary least square (OLS)	17	1.126	1.064	1.585	0.718	0.239
Seemingly unrelated regression (SUR)	51	1.210	1.158	2.118	0.390	0.341
Others	16	1.249	1.065	1.930	0.799	0.373
Functional form						
Translog	65	1.212	1.124	2.118	0.390	0.354
Others	19	1.161	1.133	1.585	0.886	0.223
Type of data						
Panel data	61	1.234	1.133	2.118	0.675	0.325
Cross section	23	1.113	1.064	1.718	0.390	0.329
Year of publication						
1981-1999	15	1.093	1.160	2.118	0.390	0.441
2000-2013	69	1.224	1.124	2.090	0.718	0.298
Number of outputs						
One output	37	1.201	1.133	2.118	0.390	0.363
More outputs	47	1.201	1.112	2.090	0.675	0.303
Income classifications						
Lower middle income	8	1.058	1.096	1.264	0.799	0.166
Upper middle income	4	1.044	1.038	1.112	0.990	0.051
High income	72	1.225	1.138	2.118	0.390	0.345

Notes: The figures of size of scale are statistically significant values taken from the selected 38 empirical studies. The one-way Anova, multiple pairwise comparisons Tukey Kramer tests, and Kruskal Wallis tests record no statistical differences of mean and median across the types of approaches and income classifications.The independent t-tests and Mann Whitney U tests found no statistical differences of mean and median across the functional forms, type of data, year of publication, and number of outputs. The income classifications are taken from the World Bank's report (2014): Lower middle income economies = Vietnam, Moldova and India; Upper middle income economies = Romania, Columbia and Brazil; and High income economies = US, Switzerland, Spain, Slovenia, Portugal, Netherlands, Japan, Italy, Germany, France and Canada.

A specific focus on size of scale based on the types of services is conducted in order to shed additional insight into the analysis of size of scale in municipal services. Local authorities are multi-functional and thus, provide a range of services. As we have seen, the restructuring of local authorities is often based on scale economies in municipal services.

Table 1 shows scale estimations by methodological features of the studies in question, with statistically significant values taken from the 38 empirical studies. The data in Table 1 refer to size of scale which range from less than one (diseconomies of scale) to greater than unity (economies of scale). The overall mean, maximum and minimum size of scale was recorded at 1.201, 2.118 and 0.390 respectively.

Several distinct characteristics of these methodologies are noteworthy. The SUR is the most widely used method with 51 studies, followed by OLS (17) and then other methods, such as ML and SFA (16). The other methods recorded the highest average size of scale at 1.249 and followed by SUR (1.210) and OLS (1.126). In the term of functional form, the TRANSLOG is the most widely used functional form with 65 studies, and 19 studies with other functional forms, such as log-log, log-linear and quadratic. Panel data records higher size of scale at 1.234 and followed by cross section (1.113). Publications of size of scale in local government tended to appear between 2000 and 2013, with 47 studies using more than one output to determine size of scale. Although most works focused on high income countries (72 studies), upper middle-income economies recorded the lowest mean of size of scale at 1.044 compared to other economies. The econometric tests also show that there were no statistical differences of size of scale in terms of mean and median.

Table 2 presents the size of scale by types of local government service. Both transport and water are the most dominant category with 37 studies, followed by waste management (5), aggregated services (3) and nursing homes (2). The highest average size of scale is recorded for aggregated services at 1.539 and followed by transport (1.270), nursing homes (1.152), water (1.125) and waste management (1.064). There are statistical differences of mean across the five types of services in EOS and DOS at 1% level, but insignificant in COS and All. The Tukey Kramer multiple pairwise comparisons of mean tests show that the EOS in transport is statistically higher than in water services; and DOS in transport is statistically lower than water. The differences in median across five types of services are not statistically significant.

The econometric results of no statistical differences in mean and median could suggest that there is no major change of size of scale in the local government services, except in water and transport services. This indicates that there are no major innovations or changes of productivity in the local government service provision. As a result, only minor cost savings can be induced by changes in size of scale.

These descriptive statistics only provide basic features of size of scale. We can examine how the methodological characteristics influence the size of scale by using meta-regression analysis, as shown below.

Table 2: Scale Elasticities by Type of Services

Type of Services	Category*	No of Sudies	Descriptive Statistics				
			Mean	Median	Max.	Min.	Std. Dev.
Transport	EOS	25	1.486	1.400	2.118	1.060	0.321
	COS	3	1.039	1.040	1.042	1.036	0.003
	DOS	9	0.747	0.799	0.990	0.390	0.221
	All	37	1.270	1.190	2.118	0.390	0.430
Water	EOS	22	1.231	1.157	1.745	1.048	0.196
	COS	5	1.028	1.030	1.040	1.004	0.015
	DOS	10	0.942	0.939	0.992	0.886	0.039
	All	37	1.125	1.078	1.745	0.886	0.201
Waste management	EOS	3	1.120	1.136	1.160	1.064	0.050
	COS	1	1.010	1.010	1.010	1.010	1.010
	DOS	1	0.950	0.950	0.950	0.950	0.950
	All	5	1.064	1.064	1.160	0.950	0.087
Nursing care	EOS	2	1.152	1.152	1.18	1.124	0.034
	COS	0	0.000	0.000	0.000	0.000	0.000
	DOS	0	0.000	0.000	0.000	0.000	0.000
	All	2	1.152	1.152	1.18	1.124	0.034
Aggregated services	EOS	3	1.539	1.560	1.585	1.471	0.060
	COS	0	0.000	0.000	0.000	0.000	0.000
	DOS	0	0.000	0.000	0.000	0.000	0.000
	All	3	1.539	1.560	1.585	1.471	0.060

Notes: *Category refers to the number of studies which found economies of scale (EOS), constant economies of scale (COS), diseconomies of scale (DOS). All refer to the total number of studies regardless of the types of scale. The figures of size of scale are statistically significant values taken from the selected empirical studies. One-way Anova tests record statistical differences of mean across the types of services under EOS and DOS but insignificant for COS and All. There is statistical difference of mean in transport and water under EOS and DOS using Tukey Kramer tests and insignificant for other pairwise multiple comparisons of mean across other types of services under EOS, COS, DOS and All. The Kruskal Wallis tests record statistical differences of median under EOS but insignificant under COS, DOS and All.

Meta-regression Model

Meta regression analysis combines common characteristics of studies that address a specific research interest and then attempts to attain a higher statistical power for the measure of interest, as contrasted with the results derived from single studies. Using 38 empirical studies, we examine a set of independent variables on the scale elasticity in the provision of municipal services.

We generate three models to examine the size of scale in the municipal services. Model I included all empirical studies, hence, provide general results on the variation of size of scale in local government services. Although local government provides a range of municipal services, each service has its own unique production technology and characteristics (Dollery and Fleming, 2006). It is thus, more meaningful if we divide the various local government services into specific services. Given that transport and water studies are statistically significant in the mean differences and embrace large number of papers, we thus, created Models II (transport studies) and III (water studies) were created to shed additional insights on the size of scale effects in these services.

The following three models were estimated:

Model I:

Allscale = *f*(OLS, SUR, TRANSLOG, PANEL DATA, YEAR OF PUBLICATION, ONE OUTPUT, HIGH INCOME, LOWER INCOME, TRANSPORT, WATER, WASTE, NURSING)

Model II:

Transportscale = *f*(OLS, SUR, TRANSLOG, PANEL DATA, YEAR OF PUBLICATION, ONE OUTPUT, HIGH INCOME)

Model III:

Waterscale = *f*(OLS, SUR, TRANSLOG, PANEL DATA, YEAR OF PUBLICATION, ONE OUTPUT, HIGH INCOME, LOWER INCOME)

We omitted two variables which were sample size and mean output volume from the Models I, II and III. These two variables did not influence scale elasticity nor improve the models. Heterogeneity and publication bias of these empirical studies are unavoidable. However, the selected studies are sufficiently similar to yield results which can be interpreted meaningfully.

These three models were run using *Eviews* software. A positive and negative sign of coefficient indicates that the independent variable increases and decreases the scale elasticity respectively.

The dependent variable (SIZE) represents scale elasticity, as reported in the literature. Although scale elasticity has average interpretation, and average performance serves to institutionalize inefficiency, a burgeoning amount of local government empirical studies still employ scale elasticity until today. It is because of the relatively ease of computational abilities of most scholars and it serves the purpose of measuring the size of scale. Secondly, each econometric approach in measuring size of scale has its own strengths and weaknesses and thus, generates different concerns. The study of scale elasticity offers an additional choice to the policy makers in decision making of local government reorganization in addition to quality factors such as management, leadership, and environment.

The independent variables are defined as follows: PANEL DATA is a dummy variable equal to one if the studies use panel data and zero otherwise. The type of data is important to be included in the regression because it indicates the dynamics of data which entail important information about the scale effects of municipal services.

OLS is a dummy variable for the ordinary least square estimation method. SUR is a dummy variable for the Seemingly Unrelated Regression and the excluded category is other methods (OMETHODS). TRANSLOG is a dummy variable for the translog functional form and the excluded category is other functional forms (OFUNCTIONALS). In general, researchers use single or various functional forms and econometric models to determine size of scale. The inclusion of these methodological characteristics is hence, necessary.

YEAR OF PUBLICATION is a dummy variable equal to one if the studies are published between 1981 and 1999 and zero if the publications fall between 2000 and 2013. The YEAR OF PUBLICATION is chosen rather than years of data drawn because the first indicates the trend and concerns of scale effects that arise in the municipal services; while the latter is a matter of availability of data in the area of research.

The income classification dummies are HIGH INCOME, equal to one for high income economies; LOWER INCOME, a dummy that takes the value of one for lower income economies. The excluded category is MIDDLE INCOME which refers to upper-middle income economies. In

Model I (all studies) and Model II (water studies), there are three types of income classifications: HIGH INCOME and LOWER INCOME, with MIDDLE INCOME is dropped from these samples. The income classifications of countries are based on the World Bank report (2014). The income classifications indicate the resource endowment of a country and therefore, determine the quantity and quality of municipal service provisions.

Local government provides multiple services. Each service provision has its own unique production characteristics (Dollery & Fleming, 2006) and thus, it is more meaningful to divide the local government services into five main categories. TRANSPORT, WATER, WASTE, NURSING are dummies for type of services which include transport, water, waste management, nursing care, and AGGSERVICE (aggregated services), which is dropped from the study.

Finally, ONE OUTPUT is a dummy variable equal to one if the studies use one output to determine size of scale and the omitted category is the MORE OUTPUT where the studies use two and above outputs to determine size of scale. In general, researchers use output and cost to form the basis requirement to measure the size of scale in the service provisions. Thus, the number of output is included in the regression to determine how it influences the size of scale.

The size of scale is greater than 0 and the independent variables are bounded between zero and one. Models I, II and III are estimated using the Tobit procedure (Wooldridge, 2009). The reported standard errors are adjusted to correct for heteroskedasticity.

RESULTS AND DISCUSSIONS

Table 3 contains the econometric results for Models I, II and III using the Tobit approach. Overall, the results of Models I, II and III are consistent. The income classification is the most important variable to determine size of scale; and all municipal services recorded decreasing size of scale, with water studies exhibiting the largest decreasing size of scale.

The coefficients for TRANSPORT, WATER, WASTE and NURSING studies are all negative and statistically significant at 1% level in Model I. Out of these four categories of local services, our results show that WATER exhibited the lowest estimate of size of scale and followed by NURSING, TRANSPORT and WASTE. This finding may suggest that water services are a non-profit orientated service which is noncompetitive, as compared to other services which require specific payments. Secondly, economies of scale in water services are almost fully exploited at a large scale of production and exhibit diseconomies of scale, given the consolidation of water sector market structure over time. Our finding of decreasing size of scale in water services is consistent with meta reviews by Bel and Warner (2008) and Carvalho et al. (2012), but it contradicts Abbott and Cohen (2009) and Walter et al. (2009). Other local government services, such as TRANSPORT, WASTE and NURSING, exhibit negative relationships with the size of scale, with mismanagement and under-utilization of services likely to set in at large scales of production. These results also contradicted to Gomez-Reino (2010) who discovered no evidence of economies of scale in garbage; and water and sanitation. Results from Model I should be treated with great concern as the regression combines all types of local government services.

High-income countries display larger size of scale in Models I and II, but are insignificant in Model III. In general, high-income countries have better production technologies and high capital investment, especially in transport systems. As a result, high-income countries can produce local government services at larger scale of production and reap greater economies of scale. The larger size of scale in high-income countries could also suggest excess capacity in transport systems (Karlaftis, McCarthy & Sinha, 1999; Fraquelli, Piacenza & Abrate, 2004).

The coefficient of LOWER INCOME displays large size of scale in Model III at the significance level of 1%. This variable is insignificant in Model I. This may suggest potential economies of scale to be exploited in water services in low-income economies (Nauges & Berg, 2008). Many low-income countries still depend on wells, rivers and streams as sources of water. In addition, the scale of urbanization is growing rapidly and there is a high demand for water services from various industries.

Table 3: Meta-regressions of Scale Elasticities in Local Government Services

Variables	Dependent Variable: Scale Elasticities		
	Model I	Model II	Model III
	All studies	Transport	Water
Constant	1.7208*** (0.1324)	0.7772*** (0.2204)	1.2369*** (0.1037)
OLS	-0.3875*** (0.1129)	-0.8765*** (0.1064)	-0.1671 (0.0979)
SUR	-0.1098 (0.0967)	-0.5137*** (0.1073)	-0.2362*** (0.0868)
TRANSLOG	-0.0084 (0.0839)	-0.7469*** (0.0463)	0.1350 (0.0754)
PANEL DATA DUMMY	0.2194 (0.1138)	0.8874*** (0.1987)	-0.0914 (0.0982)
YEAR OF PUBLICATION	-0.1527 (0.1147)	-0.0784 (0.1604)	-0.2709 (0.1497)
ONEOUTPUT	-0.0219 (0.0786)	-0.0627 (0.1455)	0.1907*** (0.0835)
HIGH INCOME	0.2272*** (0.0703)	1.0675*** (0.1332)	-0.0468 (0.0772)
LOWER INCOME	-0.1116 (0.1116)	-	0.1535*** (0.0314)
TRANSPORT	-0.6374*** (0.1591)	-	-
WATER	-0.7778*** (0.1245)	-	-
WASTE	-0.5739*** (0.0753)	-	-
NURSING	-0.7364*** (0.1449)	-	-
Log likelihood	-10.4586	-5.4636	17.1036
F χ^2	53.53***	161.74***	25.75***
	642.35***	1132.15***	205.98***
N	84	37	37

*Notes: *** Significant at the 1% level; ** significant at the 5% level. Figures in the parentheses are robust standard errors.*

The effect of estimation technique on size of scale produced mixed results. The coefficient of the variable of OLS is negative and significant in Models I and II, but insignificant in Model III. The SUR method is significant in Models II and III, but insignificant in Model I. In transport services, both methods (OLS and SUR) influenced the size of scale significantly. The result of size of scale using OLS should be treated with great care. In general, the use of OLS approach suffers from heteroskedasticity and residuals tend to correlate with independent variables and thus, lead to biased size of scale. The SUR method is the most popular and reliable estimation technique used in Models II and III, hence, provides more consistent results. The significant coefficient of SUR is opposite to the meta-analysis reviews on the private and public owned water studies by Carvalho et al. (2012), where various estimation methods were found insignificant on size of scale.

TRANSLOG is found to be statistically significant in transport studies only. The results suggest that a more flexible and reliable functional form, like translog, yields a smaller size of scale. Gomez-Reino (2010) also found that translog function yielded smaller economies of scale in various local government services. The variable of YEAR OF PUBLICATION does not influence the size of scale in every model. In transport model, our results contradict Carvalho et al. (2012), who found positive significant relationship between recent publication and size of scale.

The variable of the type of data is found positively significant in Model II only and insignificant in the Models I and III. In transport studies, panel data is more available particularly in high-income economies, and thus tends to produce more robust results. The use of panel data could control for individual heterogeneity, less collinearity among the variables, and enable researchers to construct and test more complicated behavioral models than purely cross-section or time series data (Baltagi, 2008).

Finally, the number of outputs used to determine size of scale is found significant in water studies only. Researchers tend to use one output and more uniform output to determine the size of scale in water services. Researchers could therefore, employ such an approach rather than several outputs as to determine size in other local government services.

CONCLUSION

This paper has sought to examine the relationship between the size of scale and a set of major methodological characteristics in the provision of global local government services using meta-regression analysis. The major finding of this paper is that income classification was the most important factor in determining size of scale. All municipal services recorded decreasing size of scale in the recent decades, with water studies exhibiting the largest decreasing size of scale. Our findings are consistent with the theory of scale effects which comprise of positive, negative and U-shaped functions (Andrews & Boyne, 2009; Ting et al., 2014). Our findings thus, represent a significant addition to the empirical literature on economies of scale in local government.

Although some recent publications might be overlooked and excluded from the study, the empirical evidence in this paper provides useful information that can be utilized by both policy makers and future researchers. We do not advocate decentralization of all local government services even though these services recorded decreasing size of scale since - as we have seen earlier - structural change can cause other unintended consequences.

Our findings show that the high-income countries recorded the largest size of scale in transport studies and the low-income countries exhibited the smallest variation of increasing size of scale in water studies. Thus, we suggest that the high-income economies could maintain the size of transport services and improve the quality of services instead of quantity of the service, given the excess capacity in transport systems (Fraquelli et al., 2004). In water industries, the low-income economies could exploit greater and potential economies of scale (Nauges & Berg, 2008).

Transport empirical studies (Model II) have the most statistically significant variables, as compared to other models. The employment of OLS, SUR, TRANSLOG, PANEL DATA DUMMY and HIGH INCOME were statistically significant in Model II. Thus, the results of transport empirical studies are consistent. Given that each method and functional form has its own strengths and weaknesses, it is beyond the scope of this paper to determine the best method and functional form to be employed to examine size of scale in local government services. Nonetheless, future researchers could choose SUR and translog instead of OLS functional form given their flexibility and reliability characters (Baltagi, 2008) to examine size of scale in municipal service provision.

The meta-regression results provide a more robust analysis since all the factors characterizing empirical studies are similar. However, some methodological flaws are observed. Model I combined all types of services and thus we could only derive more general results on size of scale in local government service provision, given that the output indicators are not uniform within a service, use of population as output indicator, total cost of different input prices, and the different numbers of output used to determine size of scale in the empirical studies. Despite some notable advantages of some econometric methods, limitations of different approaches and functional forms, as noted earlier, remain a challenge in determining an accurate size of scale in local government services. In addition, more specific conclusions on size of scale in waste management, nursing care and aggregated services could not be generalized, given that the size of these samples was too small.

Future research could test size of scale by enlarging the size of samples both in developed and developing countries. This is to improve the analysis of scale effects and examine scale economies for particular services or a subset of services, as to assess the relevance of scale effects in providing local government services. In addition, the use of hedonic cost functions in controlling the quality of output, which is frequently used in water studies, can be applied to other local government services. Future research effort could also be directed at performing meta-regression on empirical studies which employed DEA and other deterministic approaches to analyze size of scale. Nevertheless, our findings suggest that all municipal services, especially water utilities, demonstrate decreasing size of scale in the recent decades and that income level is the most important factor in determining size of scale.

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