

Local Government Efficiency in Western Australia

James J. Fogarty^{1*} and Amin W. Muger¹

¹School of Agricultural and Resource Economics,
The University of Western Australia,
Crawley, WA 6009, Australia
Phone: +61 8 6488 3419
Fax: +61 8 9322 3955
*Email: James.Fogarty@uwa.edu.au

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Abstract. The State government of Western Australia is currently working through a significant program of local government reform that has as a core objective a reduction in the number of local councils. The perception that there are economies of scale in service delivery is a key reason behind the State government's desire to see a reduction in the number of councils in Western Australia. The following article uses the technique of Data Envelopment Analysis to measure the technical and scale efficiency of councils in Western Australia. The average pure technical efficiency score for Western Australian councils was found to be 83 per cent, and the average scale efficiency score was found to be 94 per cent. This suggests that pure scale effects are not a major source of inefficiency. Detailed returns to scale analysis for the 73 councils where complete data was available revealed that 17 councils were operating at the optimal scale, 26 were operating below the optimal scale, and 30 were operating above the optimal scale.

Key words: Data Envelope Analysis, Local Government, Efficiency

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Introduction

The number of local councils within individual Australian States fluctuates from year to year, but the long run trend in all Australian States except Western Australia has been strongly downward. For example, Table 1 shows that over the last 100 years, in New South Wales, Victoria, Queensland, and South Australia, the number of councils has fallen by half, and that in Tasmania, the number of local councils has fallen by over 60 per cent. In Western Australia, by contrast, the number of local councils has fallen by only six per cent. In all States other than Western Australia, this also means that the average number of people served by a local council has grown much faster than population growth, whereas for Western Australia, the increase in the average number of people served by local councils is almost completely explained by population growth.¹

Table 1 Local government comparison across Australian States: 1910 and 2011

State	1910			2011			Changes		
	Council (No.)	Ave pop. (No.)	Ave size (km ²)	Council (No.)	Ave pop. (No.)	Ave size (km ²)	Council (No.)	Ave pop. (No.)	Ave size (%)
New South Wales	324	5,044	2,471	152	47,843	5,267	-172	42,800	113
Queensland	164	3,626	10,553	72	63,176	24,037	-92	59,550	128
South Australia	175	2,260	5,620	74	22,303	13,290	-101	20,043	136
Tasmania	51	3,722	1,341	31	16,429	2,206	-20	12,707	65
Victoria	206	6,207	1,104	81	68,958	2,808	-125	62,751	154
Western Australia	147	1,845	17,210	138	16,791	18,332	-9	14,946	7

Note: Population and land mass details available from www.abs.gov.au [accessed 13 September 2010]; current local council numbers available from the respective State government department websites [accessed 12 September 2011]; historical local council numbers WALGA (2008). The two mainland Australian territories, and Australia's external territories are not considered. South Australian calculations for 1910 exclude the Northern Territory, which was transferred to the Commonwealth on 1 January 1911.

It may however be argued that the total number of local councils in any given State is not relevant, but rather what is relevant is the capacity of local councils to deliver services to their respective communities. In 2009, the State government surveyed all local councils in Western

¹ As Western Australia is a geographically large State, and the north of the State is sparsely populated, measures such as the average local council population and the average local council geographic size can be slightly misleading. For example, the three largest local councils in Western Australia in geographic terms cover 735,000 km², but have a combined population of just 9,600. If these three "outlier" councils are removed from the calculation of the State average measures, then the average geographic size of local councils in Western Australia in 2011 would be 13,302 km² rather than 18,332 km², and the average population per local council would be 17,903 rather than 16,971. So, even with this adjustment, the average population served by councils in Western Australia is still the second lowest in the nation, and the average geographic size of councils is still significantly below that of Queensland, the second largest State in geographic terms.

Australia to gain an understanding of their financial health and organisational capacity. The information sought in the survey related to: strategic, financial, and infrastructure planning practices; governance, representation, and community advocacy activities; understanding of demographic issues; and organisational capacity. Some of the more striking findings of the survey were that: 82 per cent of councils undertook little or no financial planning to identify future asset maintenance and renewal gaps; 81 per cent of councils undertook little or no asset maintenance and renewal planning; 77 per cent of councils undertook little or no financial management planning; and 36 per cent of councils undertook little or no strategic planning (DLG 2010).

The information in the survey was subsequently used by the Department of Local Government to classify local councils as either: (i) having adequate organisational and financial capacity; (ii) requiring moderate structural reform; or (iii) requiring significant structural reform such as amalgamation with surrounding councils. The results of the classification exercise are reported in DLG (2010), and suggest that 44 per cent of local councils in Western Australia require significant structural reform, and a further 35 per cent of local councils require moderate structural reform.

In light of the information collected as part of the financial and organisational capacity survey, the State government's desire to see fewer local councils in Western Australia is understandable. It should however be noted that the State government announced a desire for local government amalgamations prior to undertaking the financial and organisational capacity survey. In the Minister's Press release announcing the State government objective of structural reform of the local government sector, the Minister was critical of the small size of many local councils, and indicated economies of scale and greater competition for jobs at local councils as the main benefits to flow from amalgamations.²

The claim of economies of scale benefits by the Minister is interesting, as a literature review failed to identify any studies that formally test for economies of scale in service delivery across Western Australian local councils. In terms of economies of scale in local government service delivery across Australian jurisdictions more generally, Brynes and Dollery (2002, p. 404) argue that to date, there has been no satisfactory Australian study into economies of scale in local

² John Castrilli, Minister for Local Government; Heritage; Citizenship and Multicultural Interests, Local Government Reform Strategies Announced, Press Release, Wednesday 04 February 2009, available www.mediastatements.wa.gov.au, [accessed 12 September 2011].

government service provision. As such, the assertion of the Minister that there are economies of scale benefits to be reaped through council amalgamation remains untested. Given there has been strong opposition to amalgamations from many local councils (DLG 2010), it is worth investigating the issue of council efficiency and economies of scale formally, so that clear evidence about the potential, or lack of potential, for amalgamations to deliver economies of scale or other efficiency gains can be established.

It is the objective of the following paper to formally investigate local council efficiency in Western Australia, and given the ongoing amalgamation debate, specifically consider the role of scale effects as a source of inefficiency. Measuring council efficiency is a relatively difficult task, as councils have many production inputs and outputs. It is however possible to measure the efficiency of individual local councils using the mathematical programming technique of Data Envelope Analysis (DEA) proposed by Charnes et al. (1978). To investigate local council efficiency in Western Australia the remainder of this paper proceeds as follows. First, the DEA method of measuring efficiency is explained in a non-mathematical way. Next, the relevant local government efficiency literature is reviewed, and key points noted. Summary information on the data used to measure the efficiency of Western Australian local councils is then presented, and empirical findings are discussed. Concluding comments, along with the main policy implications of the work are presented in the final section of the paper. For completeness, the paper also includes an appendix that details the specific linear program used to calculate local council efficiency scores.

Performance Benchmarking using Data Envelope Analysis Concepts

In economic studies of organisational efficiency it is common to report measures of technical efficiency, allocative efficiency, cost efficiency, dynamic efficiency, and scale efficiency. Technical efficiency refers to maximising output from the minimum level of inputs. It is the ratio of the observed output to optimal output levels for a firm relative to other firms in its cluster. Allocative efficiency means that resources are allocated to producing the things most valued by society. In the context of DEA studies, this means that the specific balance between the use of different input factors -- such as labour and capital -- is optimal, given factor prices. Cost efficiency is a measure that combines allocative and technical efficiency. Dynamic efficiency means that resources are used efficiently through time. Scale efficiency considers whether an organisation is operating at the correct scale, or is subject to increasing or decreasing returns to

scale. DEA is concerned with technical efficiency, allocative efficiency, cost efficiency, and scale efficiency (Cooper et al. 2000).

DEA studies use a linear programming technique to calculate efficiency scores.³ It is, however, difficult to gain an appreciation of the method by considering only the formal linear program. Here, the relevant aspects of DEA are explained using figures, where the examples given draw on material in SCRCSSP (1997).

Let there be five councils: A, B, C, D, and E, and let each council use two inputs -- labour and capital -- to produce a single homogeneous output under constant returns to scale.⁴ Under these conditions, the labour and capital expenses of each council, divided by the council's output, give measures that are directly comparable across councils. By plotting these standardised values in a Cartesian plane, an efficient production frontier can be identified. Specifically, the efficient production frontier is the piecewise linear curve that joins the most efficient councils. In Figure 1 the efficient frontier is found as the curve ACDE, with the curve extended parallel to the vertical axis after the observation for council A, and parallel to the horizontal axis after the observation for council E. If information on the price of labour and capital (factor prices) is available, it is also possible to construct a reference isocost line. An isocost line defines a constant level of expenditure, given different input combinations, and so the slope of the isocost line is the negative of the ratio of factor prices.

³ DEA measures performance against the level of performance achieved by an observable benchmark council -- or a linear combination of more than one observable benchmark council -- rather than an ideal benchmark. Alternative approaches to measuring performance exist, and the most prominent alternative is the stochastic frontier approach. The stochastic frontier approach defines an absolute performance benchmark, and unlike DEA requires the production technology used to be specified. Given the uncertainty about the appropriate specification for production technology in the local government sector, and a desire to measure performance against observed standards rather than theoretical standards, DEA is thought the most appropriate approach to use in the current application.

⁴ Constant returns to scale implies that a proportionate increase in inputs increases output by the same proportion.

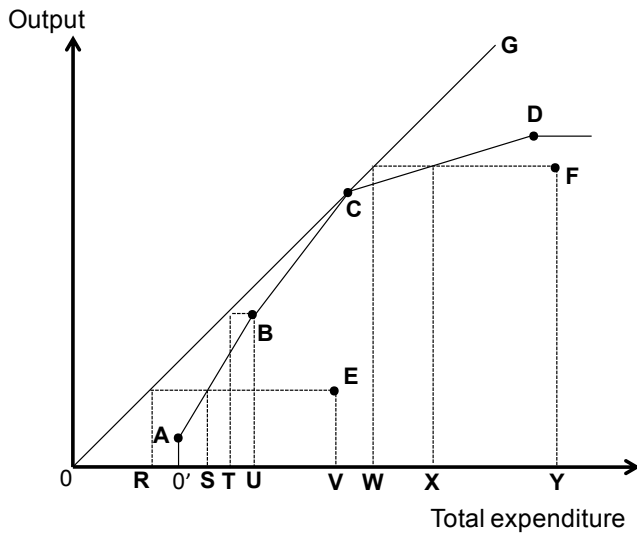
and the assumption of constant returns to scale, the point C represents the combination of labour and capital that produces a given level of output with least cost, and so only council C is allocatively efficient. For council B, the ratio OB''/OB' measures allocative efficiency. Total cost efficiency captures both technical and allocative efficiency, and for council B, total cost efficiency is found as the ratio OB''/OB . The efficiency ratios discussed above are all based on what the DEA literature refers to as a radial contraction (Subhash 2004).

Council F illustrates the problem of considering only radial contractions when measuring efficiency. For council F, a radial contraction of both labour and capital so that they equal OF'/OF of their current level would shift council F to point F' . By comparing the point F' to council E it can be seen that the point F' is not efficient. This is because an efficient council would be able to reduce labour further without reducing output. In DEA studies the distance between F' and E is referred to as a slack. The possibility of slacks means that to gain a complete understanding of local government efficiency it is necessary to consider both the efficiency ratio and the extent of slacks.

In government applications, factor price information is often unavailable, or can only be proxied very roughly. In such cases, total expenditure information is generally used with the DEA problem outlined in a slightly different manner. To illustrate the DEA framework where factor price information is not available, assume each council now produces a single homogeneous output, and that only total expenditure information is available. Now consider Figure 2. In the figure, the constant returns to scale efficient frontier is defined by the ray $0CG$, where G is a point on the ray from the origin but not an observation on a council, and council C is the only efficient council. The variable returns to scale efficient frontier allows for both increasing and decreasing returns to scale along the production frontier and is defined by the line segment $0'ABCD$.⁵ The non-increasing returns to scale efficient frontier allows for constant returns to scale and decreasing returns to scale along the production frontier and is defined by the line segment $0'CD$.

⁵ Increasing returns to scale implies that a proportionate increase in inputs increases output by a proportionately greater amount, and decreasing returns to scale implies that a proportionate increase in inputs increases output by a proportionately smaller amount.

Figure 2 Identifying the sources of inefficiency



For council E, the constant returns to scale efficiency score measured under an input orientation is $0R/0V$; the variable returns to scale efficiency score is $0S/0V$; and the non-increasing returns to scale efficiency score is $0R/0V$. The total inefficiency of local council E can then be decomposed into technical inefficiency, and inefficiency due to operating at the incorrect scale (scale efficiency). To determine whether the scale inefficiency is due to the council being too big or too small, the non-increasing returns to scale efficiency score is compared to the constant returns to scale efficiency score. When the non-increasing returns to scale and constant returns to scale efficiency scores are equal, but differ from the variable returns to scale efficiency score, the local council is operating under increasing returns to scale, and relative to the optimal size, the council is too small. On the other hand, if the variable returns to scale and the non-increasing returns to scale efficiency scores are equal, but differ from the constant returns to scale efficiency score, diminishing returns to scale holds, and the council is operating a scale that is larger than optimal. A council is operating at an optimal size when the three measures coincide (Ray 2004). For council E, since the non-increasing returns to scale efficiency score is equal to the constant returns to scale efficiency score, but not equal to the variable returns to scale efficiency score, the source of the scale inefficiency for council E is due to the council being below the optimal size.

In Figure 2, council B has an efficiency score of $0T/0U$ under constant returns to scale, and an efficiency score of $0U/0U = 1$ under variable returns to scale. As such, the only source of inefficiency for council B is due to operating at the incorrect scale. As the non-increasing returns to scale efficiency score $0T/0U$ is the same as the constant returns to scale efficiency score, it can be established that council B is too small, and is subject to increasing returns to scale. Council C is

efficient and is operating at the correct scale. Council F is scale inefficient and technically inefficient. As the non-increasing returns to scale efficiency score OX/OY is greater than the constant returns to scale efficiency score OW/OY , council F is larger than the optimal scale, and hence is subject to decreasing returns to scale.

The standard form of the DEA linear program used is specified in detail in numerous textbooks, including Cooper et al. (2000), and the software required to implement the DEA linear program is widely available. For completeness, the formal mathematical specification of the linear program used to calculate efficiency scores is given in the appendix. Actual efficiency scores were calculated using the FEAR package in R.

Previous Local Government DEA Studies

There have been numerous DEA studies of local government efficiency, and the literature prior to 2000 is well summarised in Worthington and Dollery (2000a). Much of the subsequent literature concerns countries other than Australia, and as council functions vary widely from country to country, the relevance of the DEA model specification in terms of inputs and outputs in non-Australian examples is somewhat limited. As such, the literature reviewed here is restricted to Australian examples. All of the Australian examples identified consider council efficiency in New South Wales, with five studies considering efficiency across specific service areas, and one study considering overall council efficiency. The studies that consider a single service area are relevant, in that they provide insight on the type of inputs and outputs to consider, and the extent of scale inefficiency across individual service areas, but these studies are not as relevant as Worthington (2000), which considers overall council efficiency. The studies considering a single service area are summarised in Table 2, and in terms of scale efficiency, it is worth noting that incorrect scale was found to be a significant source of inefficiency in the provision of library services, but was a relatively minor contributor to inefficiency in planning and regulatory services, waste services, and water services. From these studies it is therefore unclear whether scale effects are a significant source of inefficiency at the whole of council level.

In Worthington (2000), overall council efficiency is measured using both a DEA approach and a stochastic frontier approach, but given the focus of the current study, the discussion is limited to the DEA results only. The DEA model used allowed for variable returns to scale, and conceptually, was of a form consistent with that outlined in Figure 1. As such, technical efficiency, allocative efficiency, and total cost efficiency measures were calculated. The council functions

identified were: (i) financial services, (ii) library services, (iii) environmental services, (iv) planning and regulatory services, (v) recreation services, (vi) community services, (vii) waste management services, (viii) sewage services, (ix) water supply services, and (x) roads. The output proxies used for the different services reflect the assessment factors used by the NSW Department of Local Government, and the output proxy used for service areas (i) - (vi) was population; the output proxy used for service areas (vii) - (ix) was the number of properties served; and the output proxies for service area (x) were kilometres of sealed urban roads, sealed rural roads, and unsealed rural roads.

The three inputs selected to match the seven output proxies were: (i) the number of full-time equivalent staff, (ii) expenditure on materials and inventories (excluding depreciation), and (iii) capital expenses on loans and borrowings. As no proxy measure of physical capital was considered, the assumption in the study is that physical capital is used in fixed proportions to other inputs; which is a reasonable assumption. The average salary in each council was used as the price of labour, and a proxy price for non-labour expenditure was derived by dividing total other physical expenditure by current assets. The price used for financial expenses was the average interest rate paid on borrowed funds.

The average cost efficiency score for NSW councils was .699, the average allocative efficiency score was .821, and the average technical efficiency score was .853. Although the average technical and allocative efficiency scores are similar, there was a significant difference in the distribution of efficiency scores; with 76 of the 176 local councils in the sample achieving technical efficiency, but only 30 councils achieving allocative efficiency. As a variable returns to scale model was specified, the results remove the impact of scale effects, and no information on scale as a source of inefficiency was reported.

In summary, all the evidence on local government efficiency in Australia comes from New South Wales, and most of this evidence relates to data collected in 1993. There is no direct evidence on the role of scale effects at the overall council level, but there is some evidence that scale effects were a significant source of inefficiency in library services in NSW in 1993.

Table 2 Local government specific service DEA studies for Australian local councils

No.	Author(s)	Function	Sample & (data year)	Inputs and Outputs ^a	Efficiency Scores ^b	Main findings
1.	Worthington (1999)	Library services	168 NSW councils (1993)	Output: No. library issues Inputs: Gross library expenditure, population, area, NESB, socioeconomic index	CRS: .28 (9.5%) VRS: .71 (47.6%) Scale: .42 (10.1%)	Scale is the main source of inefficiency, and a population of 20,000-30,000 is optimal for library services.
2.	Worthington and Dollery (2000b)	Planning and regulatory services	173 NSW councils (1993)	Outputs: No. building applications and no. development applications determined Inputs: Planning expenditure, legal expenditure, no. FTE staff, population growth, development activity index, heritage and environment index, proportion of non-residential properties, population distribution, NESB	CRS: .79 (53.8%) VRS: .83 (64.2%) Scale: .94 (56.1%)	Scale inefficiency in the planning and regulatory function is not a widespread or significant problem. The main source of inefficiency for urban councils is excessive legal expenses and the main source of inefficiency for rural councils is excessive staff numbers.
3.	Worthington and Dollery (2001)	Domestic waste services	103 NSW councils (1993)	Outputs: Total garbage and recyclables collected, implied recycling rate Inputs: Waste collection expenditure, no. properties served, average occupancy rate, population density, population distribution, waste disposal cost index	CRS: .56 (26.2%) VRS: .67 (40.8%) Scale: .85 (82.5%)	Modelling efficiency scores using a logit framework indicates urban developed and rural agricultural councils as least likely to be efficient. For urban councils a key source of inefficiency relates to the inability to effectively use large machinery.
4.	Worthington and Dollery (2002)	Planning and regulatory services	173 NSW councils (1993)	Outputs: No. building applications, and development applications determined and approved Inputs: Planning expenditure, legal expenditure, no. FTE staff, population growth, development activity index, heritage and environment index, proportion of non-residential properties, population distribution, NESB	VRS: .94 to .53 (77.5% to 19.1%) Scale: .95 to .63 (52.6% to 6.4%)	Efficiency scores vary depending on how contextual information is incorporated into the DEA model.
5.	Woodbury and Dollery (2004)	Water services	73 NSW councils (2000)	Outputs: No. assessments, water consumption, water quality index, service index Inputs: Cost for management, maintenance and operations, energy and chemicals, and capital replacement	CRS: .74 (20.5%) VRS: .80 (30.1%) Scale: .92 (20.5%)	In water service provision 47 per cent of councils face decreasing returns to scale and 27 face increasing returns to scale. Total annual factor productivity growth was about 1.15 per cent.

Notes: ^a NESB: Non-English speaking background population share.

^b Efficiency scores are mean values, with the per cent of efficient local councils in parenthesis. CRS is the overall technical efficiency score. VRS is the variable returns to scale, or pure technical efficiency score; Scale is the scale efficiency score, which is found as CRS/ VRS.

Data, Results, and Discussion

For the analysis, the original intention was to use information submitted by councils to the State government as part of annual reporting processes. Unfortunately, the data submitted by a significant number of councils was found to be inaccurate.⁶ As such, the data collection process involved checking each council's website, and where possible, downloading a copy of the annual financial statements. The values required for the study were then transcribed directly from the financial statements. Using this process it was possible to obtain data for 73 of the 138 Western Australian local councils for the financial year ending June 2009.

The focus of the study is to measure efficiency over the entire range of local government activities, which in Western Australia includes: (i) library services, (ii) environmental services, (iii) recreation services, (iv) community services, (v) planning and regulatory services, (vi) waste management and recycling services, and (vii) road maintenance services. The output proxy used for services (i) - (iv) is the population of the local council area; the output proxy used for services (v) and (vi) is the number of properties in the local council area; and the output proxies used for service (vii) are the length of sealed and unsealed roads in kilometres, where for sealed roads a quality adjusted measure was calculated by taking the total length of sealed roads and dividing through by the road condition index value reported in WALGA (2010). These output proxies are broadly consistent with the approach taken in Worthington (2000) and Balaguer-Coll et al., (2007).

The inputs selected were employee costs, physical expenses, and financial expenses, where: employee costs are total employee expenses, including superannuation liability; physical expenses consist of materials purchased, contract expenses, utility expenses, insurance costs, and any costs grouped under the heading 'other expenses' in the financial statements; and financial expenses relate to interest expenses. Again, the selection of inputs is consistent with the approach taken in the existing literature. A summary of the input and output data used to calculate council efficiency scores is provided in Table 3. It can be noted that proxy measures of price are not used, and so the analysis is conceptually similar to the approach outlined in Figure 2.

⁶ The data quality evaluation process involved comparing select values reported in the annual information return submitted by councils to the State government to the corresponding values reported in the annual audited financial accounts for a sample of councils. The number of inconsistencies identified using this process meant that we did not have confidence in the quality of the data submitted by councils to the State government as part of the information return process.

Table 3 Summary information on the inputs and outputs used

	Units	Mean	Maximum	Minimum	St. Dev.
Outputs					
Population	No.	13,685	102,434	422	21,468
Quality adjusted sealed roads	km	182	925	7	153
Unsealed roads	km	632	4,810	0	789
Properties served	No.	6,458	43,496	313	8,887
Inputs					
Employment costs	(\$)	6,177,494	42,700,000	688,707	7,625,743
Physical expenses	(\$)	6,706,253	57,200,000	660,127	8,940,135
Financial expenses	(\$)	152,628	1,322,148	0	250,888

Note: Where a value of zero is recorded for an input or output this is replaced with a value of one in the DEA linear program.

A summary of the efficiency score information is provided in Table 4.⁷ The upper panel of the table shows that the average technical efficiency score for the 73 councils was 78 per cent under constant returns to scale, and 83 per cent under variable returns to scale. This means that at the average Western Australian council, a proportional reduction in the combination of inputs to 78 per cent of their current level is required to achieve efficiency. The average scale efficiency score of 94 per cent can be interpreted as indicating that pure scale inefficiency is responsible for only six per cent of observed technical inefficiency. This finding suggests that scale effects are not the main source of inefficiency across the Western Australian local government sector. Rather than incorrect scale, the main source of inefficiency appears to be inefficient use of inputs, or other managerial factors not captured by the DEA model. Given the current debate about amalgamations in Western Australia, this is an important finding.

The lower panel of Table 4 provides information on the distribution of efficiency scores. In global technical efficiency terms the efficient frontier is defined by 17 councils, and a further nine councils have pure technical efficiency scores greater than 90 per cent. Allowing for variable returns to scale allows for a measure of pure technical efficiency, and under variable returns to scale, the efficient frontier is defined by 31 councils, with a further six councils achieving efficiency scores greater than 90 per cent. Given the mean scale efficiency score was 94 per cent, the distribution of scale efficiency scores is not surprising. Specifically, 23 per cent of the sample achieved scale efficiency, and a further 55 per cent of the sample achieved a scale efficiency score greater than 90 per cent. The distribution table for scale efficiency scores does however show that there are a small number of local councils with high levels of scale inefficiency.

⁷ As a robustness check, the model was also estimated using the unadjusted measure for roads. The results from this alternative specification were almost identical to the results presented in Table 4.

Table 4 Summary efficiency information

	CRS efficiency	VRS efficiency	Scale efficiency
Mean	.777	.831	.937
Maximum	1.00	1.00	1.00
Minimum	.385	.412	.394
St. Deviation	.194	.187	.102
Distribution			
< 40%	2	0	1
41 – 50%	6	5	0
51 – 60%	9	9	1
61 – 70%	10	6	0
71 – 80%	8	10	2
81 – 90%	12	6	12
91- 99%	9	6	40
100%	17	31	17

As a key motivation for undertaking the study was to understand the relationship between council size and efficiency, councils were further identified as: operating under constant returns to scale (optimal size), operating under increasing returns to scale (too small), or operating under decreasing returns to scale (too big). Of the 56 local councils identified as not operating at the optimal scale, 30 were identified as subject to decreasing returns to scale, and 26 as subject to increasing returns to scale. Table 5 provides details on the mean values for different characteristics of councils subject to constant returns to scale, decreasing return to scale, and increasing returns to scale.

In broad terms, the information in Table 5 suggests that, on average, there are notable differences between the characteristics of councils operating at the correct scale, councils subject to decreasing returns to scale, and councils subject to increasing returns to scale. On average, local councils operating under decreasing returns to scale tend to incur higher costs than councils operating at the optimal scale; and conversely, local councils operating under increasing returns to scale tend to incur lower costs than councils operating at the optimal scale. Note, however, that the average population served by councils operating at the optimal scale, too big a scale, and too small a scale varies substantially. As such, it is worth standardising average total expenditure by dividing through by the average population and the average number of properties served. As can be seen by comparing these standardised values, average per capita expenditure at councils operating under decreasing returns to scale is 40 per cent higher than average per capita expenditure at councils operating at the correct scale; and average per capita expenditure at councils operating under increasing returns to scale is 83 per cent higher than average per capita expenditure at councils operating at the correct scale.

The final two rows of Table 5 provide information on the average pure technical efficiency score and the average scale efficiency score for each of the three groups of councils. As can be seen from the reported mean VRS efficiency values, in pure technical efficiency terms, councils that are too small are slightly more inefficient than councils that are too big. Similarly, as can be seen from the reported mean scale efficiency values, scale effects, as a source of inefficiency, are slightly more important for councils that are too small than for councils that are too big. However, for both councils that are too big and councils that are too small, pure scale effects are not the main source of inefficiency.

Table 5 Local council characteristics based on returns to scale

	Units	Optimal size	Too big	Too small
Sample size	No.	17	30	26
Population	No.	17,135	20,238	3,868
Quality adjusted sealed roads	Km	236	231	90
Unsealed roads	Km	874	624	481
Properties served	No.	7,512	9,708	2,018
Employment costs	(\$)	5,311,973	9,758,400	2,126,054
Physical expenses	(\$)	6,564,460	9,782,830	2,739,377
Financial expenses	(\$)	103,386	248,439	74,272
Total expenses	(\$)	11,979,818	19,789,669	4,939,703
Total expenses/population served	(\$)	699	978	1,277
Total expenses/ properties served	(\$)	1,595	2,038	2,448
Mean VRS efficiency score	(%)	100	79	77
Mean Scale efficiency score	(%)	100	93	91

* Note: Reported values are means.

Regression analysis can be used to further explore the relationship between council attributes and efficiency scores, and between council attributes and slacks. Here, two different regression models are considered. In both regression models the inputs and outputs from the DEA analysis are included as explanatory variables, as are two other factors that are potentially important in explaining efficiency scores: population density, and the Australian Bureau of Statistics (ABS) relative socio-economic disadvantage index value. In regression model (1), the variable returns to scale efficiency score is the dependent variable. As the scores are truncated at one, a Tobit regression model is specified, and the method of estimation is maximum likelihood. Regression model (2) uses the sum of the input and output slacks for each council as the dependent variable, and the method of estimation is least squares.⁸ To aid with exposition, all coefficients for regression model (1), except the intercept term, have been multiplied by 100,000.

⁸ Additional regressions were also estimated where the sum of the input slacks and the sum of the output slacks were considered separately as the dependent variable. The results from these additional regressions are consistent with the results reported in Table 6 that use the combined sum of the input and output slacks.

Table 6 Regression model exploration of council inefficiency

Variable	Model 1 ^a		Model 2	
	Estimate	SE	Estimate	SE
Population (No.)	-.821	(.629)	3.48	(62.95)
Property served (No.)	3.91**	(1.79)	-292	(229)
Quality adj. sealed roads (km)	99.2***	(29.8)	-6,872**	(2,684)
Unsealed roads (km)	.086	(5.13)	36.89	(313.61)
Employees cost (\$)	-.002**	(.001)	.479*	(.264)
Physical expenses (\$)	-.001	(.001)	-.022	(.151)
Financial expenses (\$)	-.013	(.010)	3.77***	(.748)
Population density (per km ²)	5.99	(4.24)	22.5	(429)
Disadvantage index (No.)	-23.0	(41.9)	-2,294	(3,766)
Constant	.946	(.416)	2,889,160	(3,692,105)
R ²	NA		.679	

*** Significant at the 1 per cent level, ** significant at the 5 per cent level * significant at the 10 per cent level. All standard errors are robust standard errors.

^a All coefficients for model 1, except the intercept, have been multiplied by 100,000.

For regression model 1, other factors held constant, pure technical efficiency in local councils: (i) increases as the number of properties served increases; (ii) increases as the size of the sealed road network increases; and (iii) decreases as employee expenses increases. Although these effects are statistically significant, it is also important to establish whether the effects are practically significant. The average council identified as being below the optimal size served 2,018 properties, had a quality adjusted sealed road network of 90 kms, and had employee expenses of \$2.1 million. Regression model 1 says that doubling the number of properties served by the average below scale council would raise the variable returns to scale efficiency score by around .08; doubling the size of the quality adjusted sealed road network would raise the variable returns to scale efficiency score by around .09; and reducing employment costs by 10 per cent would raise the variable returns to scale efficiency score by around .004.⁹ These results, combined with the scale effects results, can be interpreted as indicating that, on average, larger councils are more efficient than smaller councils, but that this effect is not due to pure economies of scale effects.

For regression model 2, there is no natural interpretation to the size of the coefficients, but the sign of the coefficients still provides useful information. Specifically, regression model 2 says that slacks decrease with: (i) increases in the size of the sealed road network; (ii) decreases in financial costs; and (iii) decreases in financial expenses. Although neither population nor properties served are statistically significant in regression model 2, the correlation between these

⁹ In this case, the marginal effects for the Tobit model vary little across the relevant range, and are approximately equal to the point estimates shown in Table 5. As such, in this specific case, multiplying the point estimate by the change in the explanatory variable gives a good indication of the impact of a change in an explanatory variable on efficiency scores.

two variables is 98 per cent. As such, despite being statistically insignificant individually, it is possible that these two variables are jointly significant. For regression model 2, the F-statistic for a joint test of significance on population and properties is 7.8, which is above the one per cent critical value. As such, it can be concluded that population and properties served have an impact on the extent of slacks. By sequentially dropping each variable it was found that increases in population and properties served are associated with a reduction in slacks. Taken together, the information from regression model 2 suggests that the extent of slacks is lower for larger councils, and hence there is an efficiency gain from moving towards larger councils that is independent of scale effects. For regression model 2, it is impossible to quantify the extent of the possible gains.

The socio-economic disadvantage measure is calculated using information on the unemployment rate, the share of low-income households, the proportion of the population with low educational attainment, and the proportion of households without a car; and higher values indicate less relative socio-economic disadvantage. It was hypothesised that councils in areas of greater relative socio-economic disadvantage might face organisational challenges not adequately captured in the DEA linear program and that this would in turn mean that councils where socio-economic disadvantage is greatest would have both lower efficiency scores and higher levels of slacks. Based on the results from regression models 1 and 2, there is no evidence of such a relationship. As a possible explanation for this finding it can be noted that income growth in Australia has been strong in recent years, and that between 1998 and 2008 real incomes for low income households grew by 41 per cent (ABS 2010). As such, it may be that even in areas where relative socio-economic disadvantage is greatest, the average level of household income in these areas is now such that service delivery in these areas is not fundamentally more difficult than in areas of relative wealth.

Western Australia is over 2.5 million km² in size, and some areas of the State are sparsely populated, while the area around the State capital, Perth, is relatively densely populated. The population density at councils therefore varies dramatically. Around Perth, there are numerous councils where the population density is greater than 2,000 people per km², while in the north of the State there numerous councils where the population density is less than .01 people per km². It was hypothesised that where population density is very low, councils may face organisational challenges not captured in the DEA linear program, and so there may be a relationship between population density and both efficiency and slacks. Based on the results reported in Table 6, there is no evidence of a statistically significant relationship between population density and either efficiency scores or slacks. Although somewhat speculative, a possibly explanation for this finding could be that in sparsely populated areas service standards have been set to reflect the practical challenges of service delivery in these areas.

5 Conclusions

This study used the technique of Data Envelope Analysis to investigate council efficiency in Western Australia and identify the contribution of scale effects to overall sector inefficiency. Complete data was available for 73 councils, and, on average, councils were found to be operating with technical inefficiencies. Returns to scale analysis indicated that 17 councils were operating at the optimal scale, 26 were operating below the optimal scale, and 30 were operating above the optimal scale. The main source of technical inefficiency was in the use of inputs rather than pure scale effects, and in terms of the council amalgamation debate in Western Australia, this is an important finding. Regression analysis was used to investigate the relationship between efficiency and council attributes, and it was found that rather than the socio-economic profile of the council area, the input use decisions made were the main source of inefficiency. It was also found that independent of scale effects, larger councils are, on average, more technically efficient than smaller councils.

The main limitation of the study is that not all councils in Western Australia were considered. If the performance of councils for which data was not available is substantially different to the sample considered, the conclusions drawn about the main source of inefficiency may change. The main policy implication from the study is that the debate on the amalgamation of councils to improve their financial health needs to be handled with caution. Policies that encourage consolidation only make economic sense if larger councils tend to be more efficient than smaller councils, and if merging will improve both pure technical efficiency and scale efficiency. The results suggest that there will be a number of possible council amalgamation scenarios that meet this criteria, but also a large number of amalgamation scenarios that do not.

Appendix

The linear program used to obtain efficiency scores for each council is given below, and in this instance the notation follows that of Worthington (2000).

Let there be L councils, and let each council use K inputs to produce M outputs. Let x_i be a $K \times 1$ vector containing all information on the inputs used by council i , and let y_i be an $M \times 1$ vector containing all information on outputs for council i . Complete information on council i is therefore contained in x_i and y_i . Combining the respective vectors for each council gives X , the $K \times L$ input matrix, and Y , the $M \times L$ output matrix. The relative efficiency of each council can then be found as:

$$\max_{\mu, v} (u'y_i/v'x_i)$$

$$\begin{aligned}
& s. t. u'y_j/v'x_j \leq 1 \\
& u, v \geq 0 \\
& v'x_j = 1,
\end{aligned}$$

where y_i and x_i are as defined above, u is a $M \times 1$ vector of output weights, v is a $K \times 1$ vector of input weights, i runs from 1 to L , j equals 1, 2, ..., L , and the prime denotes the transpose of a vector. The objective function uses weight vectors that maximise the efficiency score subject to three constraints. In the above, the first constraint ensures that the efficiency score cannot exceed one, and the second constraint ensures that the individual elements of the weight vectors are non-negative. The final constraint serves to ensure a unique solution. The above fractional linear programming problem is then transformed to the linear programming problem:

$$\begin{aligned}
& \max_{\mu, \nu} (u'y_i) \\
& s. t. u'_j \\
& \mu, \nu \leq 0 \\
& v'x_j = 1,
\end{aligned}$$

where the notation change from u and v to μ and ν reflects this transformation. Next, the dual minimisation problem is found, which in this case is:

$$\begin{aligned}
& \min_{\theta, \lambda} \theta \\
& s. t. -y_i + \gamma\lambda \geq 0 \\
& \theta x_i - X\lambda \geq 0 \\
& \lambda \geq 0,
\end{aligned}$$

where θ is a scalar, and λ is a $L \times 1$ vector of constants. In the above specification the value θ is the technical efficiency score for an individual council under constant returns to scale. If the additional constraint that $L1'\lambda = 1$ is added to the above problem, the value θ becomes the technical efficiency score for an individual council under variable returns to scale. Finally, if the constraint $L1'\lambda \leq 1$ is added to the above problem the value θ becomes the technical efficiency score for an individual council under non-increasing returns to scale.

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