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by

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Abstract

In this study the nature and extent of efficiency and productivity growth in Australian local government is investigated using nonparametric frontier techniques. Employing Malmquist indices, productivity growth is decomposed into technical efficiency change and technological change for two important local government functions; namely, domestic waste management and recycling services, and planning and regulatory services. The results indicate that there was little or no productivity growth at the frontier during the period in question, although there was substantial improvement in the relative efficiency of nearly all councils in both functions. That productivity growth which did occur appears largely due to an increase in efficiency over the period, with improvements in scale efficiency dominating for larger, urban developed councils, and improvements in technical efficiency being notable for smaller, rural agricultural councils.

Key Words: local government, technical efficiency, state efficiency, domestic waste management, planning and regulatory services

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1. Introduction

Beginning with the Campbell Report in 1981, microeconomic reform of the Australian economy has dominated the policy agenda for almost two decades. But the actual implementation of reformist policies has been by no means easy nor evenly spread across the economy. In its 1996 *Stocktake of Progress in Microeconomic Reform* the Productivity Commission (1996: 28) summarised the nature of Australian microeconomic reform as follows:

> Despite significant achievement, progress in reform has not been uniform either across sectors or across government jurisdictions. In some areas, reforms has been comprehensive. In others, it has barely started or has proceeded at a frustratingly slow pace, leaving much unfinished business. Some States have advanced further and faster than others. While the States are lagging in some areas, in others – such as industrial relations reform and privatisation – some have progressed further with market-oriented reform than has the Commonwealth.

In the public sector, the pace of reform has been particularly uneven. In general, it is reasonable to argue that microeconomic reform has already had a substantial impact on the management of the Commonwealth public service. Moreover, it has also had significant effects on the operations if most State bureaucracies, especially in Victoria. However, the microeconomic reform process is much less advanced in local government. Despite the fact that only about 4 percent of total government revenues and around 5 percent of total government outlays occur in Australian local government (Productivity Commission 1996: 175), municipalities nevertheless spent in excess of $10.5 billion and employed some 156,000 people (Johnstone 1995: 13). Accordingly, considerable gains would flow from the comprehensive reform of local government in Australia. This has widely been recognised by commentators on the reform debate. For example, the then Commonwealth minister for Local Government, Warwick Smith (1996: 1) argued in his address to the National General Assembly of Australian Local Government Associations on 3 December 1996 that:

> All governments must anticipate and react to continual change and respond to rising pressures from the community, business and government sectors to improve efficiency and effectiveness of their services. Local government is no exception.

The present paper is concerned with the empirical assessment of local government performance in the Australian state of New South Wales over the period 1993/94 to 1995/96. Traditional approaches to productivity measurement have generally assumed that observed output is best-practice or frontier output. Accordingly, productivity growth, as measured by either partial productivity or total factor productivity indices (an index of output divided by an index of total input usage), is synonymous with technical progress (or shifts in the technology boundary). However, in a world in which inefficiency exists, total factor productivity can no longer be interpreted as technical change unless there is either no technical inefficiency or unless technical inefficiency does not change over time. If these conditions do not hold, then total factor productivity is redefined as the net effect of changes in efficiency (or movements relative to the existing frontier) and shifts in the production frontier (or technical change). This distinction is important from a policy viewpoint, since changes in productivity growth due to inefficiency suggest different policies to those concerning technical change (Grosskopf 1993: 169). For example, slow productivity growth due to inefficiency may be due to institutional barriers to the diffusion of innovations. In this case, policies to remove these barriers may be more effective in improving productivity than those aimed at innovation *per se*.

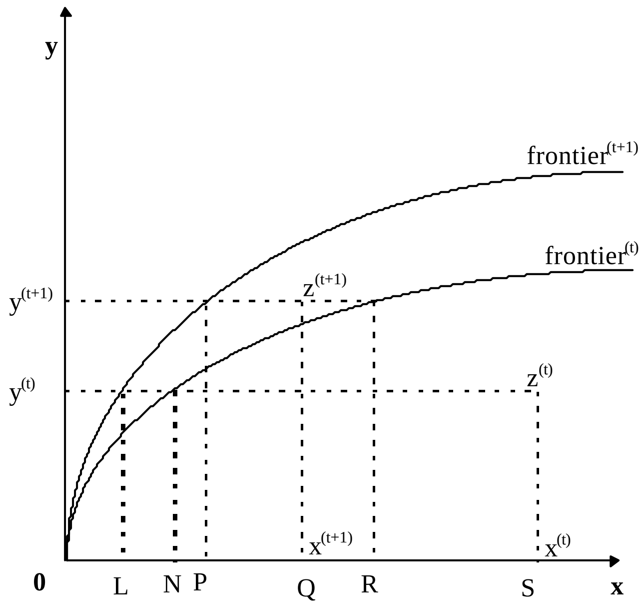
These issues are especially important given the pace of microeconomic reform in Australian local government. Undoubtedly, reform *per se* and the anticipation of reform has affected the sector's choice of input and output volumes. However, little is known about the effect of these reforms on productivity growth, and even less about the spread of productivity levels across the sector. By comparing annual changes in the productivity of individual councils, it is possible to both identify general trends in the productivity of local government as a whole, and to identify individual councils exhibiting patterns of change in productivity that differ from the rest of the sector. A careful analysis of the results should add to our knowledge about the factors determining the pattern of local public sector productivity in Australia and provide at least some idea of the effectiveness of microeconomic reform.

The paper itself is divided into four main sections. Section 2 focuses on the theoretical background to Malmquist indexes of productivity and technical change. Section 3 deals with the specification of inputs and employed in the evaluation of technical efficiency and technical change in two kinds of local public services in NSW local government, namely domestic waste management and recycling services, and planning and regulatory services. Section 4 presents the resultant indices of productivity, efficiency and technical change and assesses their significance. The papers ends with some concluding remarks in the final section.

2. Malmquist indexes of productivity and technical change

The framework employed in the current study can be illustrated by Figure 1 following Fare *et al*. (1990; 1993), Hjalmarsson and Veiderpass (1992), Berg, Forsund and Jansen (1992), and Price and Weyman-Jones (1996). In this diagram, a production frontier representing the efficient level of output (y) that can be produced from a given level of input (x) is constructed, and the assumption made that this frontier can shift over time. The frontiers thus obtained in the current (t) and future (t+1) time periods are labelled accordingly. When inefficiency is assumed to exist, the relative movement of any given council over time will therefore depend on both its position relative to the corresponding frontier (technical efficiency) and the position of the frontier itself (technical change). If inefficiency is ignored, then productivity growth over time will be unable to distinguish between improvements that derive from a council 'catching up' to its own frontier, or those that result from the frontier itself shifting up over time.

Figure 1. Malmquist index and productivity changes over time



Now for any given council in period t, say, represented by the input/output bundle $z(t)$, an input-based measure of efficiency can deduced by the horizontal distance ratio $0N/0S$. That is, inputs can be reduced in order to make production technically efficient in period t (i.e. movement onto the efficient frontier). By comparison, in period $t + 1$ inputs should be multiplied by the horizontal distance ratio $0R/0Q$ in order to achieve comparable technical efficiency to that found in period t. Since the frontier has shifted, $0R/0Q$ exceeds unity, even though it is technical inefficient when compared to the period $t + 1$ frontier.

It is possible using the Malmquist input-based productivity index to decompose this total productivity change between the two periods into technical change and technical efficiency change. An input-based productivity index is used since it is generally argued that an input-orientation is consistent with the notion that local government outputs are largely given and the focus is on reducing inputs (proportionately) as much as possible, given technology. Fare, Grosskopf, Lindgren and Roos (1993) have calculated these input-based Malmquist productivity measures for a sample of (government-controlled) Swedish pharmacies. Berg, Forsund and Jansen (1991) have also employed an input-orientated approach to analyse the effects of deregulation in Norwegian financial services. And Fare, Grosskpf, Yaisawarng, Li and Wang (1990) applied Malmquist input-based productivity measures to evaluate productivity growth in Illinois utilities. Following Fare, Grosskopf and Lovell (1994), the input-based Malmquist productivity change index may be formulated as:

$$M_I^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) = \left[\frac{D_I^t(y^{t+1}, x^{t+1})}{D_I^t(y^t, x^t)} \times \frac{D_I^{+1t}(y^{t+1}, x^{t+1})}{D_I^{+1t}(y^t, x^t)} \right]^{1/2}$$

(1)

where the subscript *I* indicates an input-orientation, *M* is the productivity of the most recent production point (x^{t+1}, y^{t+1}) (using period $t + 1$ technology) relative to the earlier production point (x^t, y^t) (using period *t* technology), and all other variables are as previously defined. A value greater than unity will indicate positive total factor productivity growth between the two periods. Following Fare, Grosskopf, Lindgren and Roos (1993) an equivalent way of writing this index is:

$$M_I^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) = \frac{D_I^{t+1}(y^{t+1}, x^{t+1})}{D_I^t(y^t, x^t)} \left[\frac{D_I^t(y^{t+1}, x^{t+1})}{D_I^{t+1}(y^{t+1}, x^{t+1})} \times \frac{D_I^{+1t}(y^t, x^t)}{D_I^{+1t}(y^t, x^t)} \right]^{1/2} \quad (2)$$

or

$$M = E \cdot P \quad (3)$$

where

$$E = \frac{D_I^{t+1}(y^{t+1}, x^{t+1})}{D_I^t(y^t, x^t)}$$

$$P = \left[\frac{D_I^t(y^{t+1}, x^{t+1})}{D_I^{t+1}(y^{t+1}, x^{t+1})} \times \frac{D_I^{+1t}(y^t, x^t)}{D_I^{+1t}(y^t, x^t)} \right]^{1/2} \quad (4)$$

where *M* (the Malmquist total factor productivity index) is the product of a measure of technical progress *P* (the two ratios in the square bracket) as measured by shifts in the frontier measured at period $t + 1$ and period *t* (averaged geometrically) and a change in efficiency *E* over the same period (the term outside the square bracket).

In order to calculate these indices it is necessary to solve several sets of linear programming problems. Since the input distance function is equal to the reciprocal of the Farrell input-orientated measure of technical efficiency for each council, we compute four separate input distance functions. The first two LPs are where the technology and the observation to be evaluated are from the same period, and the solution value is less than or equal to unity. The second two LPs occur where the reference technology is constructed from data in one period, whereas the observation to be evaluated is from another period. Assuming constant returns-to-scale to start with, the following input-orientated LPs are used:

$$\begin{aligned} \left[D_I^t(y_t, x_t)\right]^{-1} &= \min_{\theta,\lambda} \theta \\ s.t. -y_{ti} + Y_t \lambda &\geq 0 \\ \theta x_{it} - X_t \lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \quad (5)$$

$$\begin{aligned} \left[D_I^{t+1}(y_{t+1}, x_{t+1})\right]^{-1} &= \min_{\theta,\lambda} \theta \\ s.t. -y_{ti,+1} + Y_{t+1} \lambda &\geq 0 \\ \theta x_{i,t+1} - X_{t+1} \lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \quad (6)$$

$$\begin{aligned} \left[D_I^{t+1}(y_t, x_t)\right]^{-1} &= \min_{\theta,\lambda} \theta \\ s.t. -y_{it} + Y_{t+1} \lambda &\geq 0 \\ \theta x_{it} - X_{t+1} \lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \quad (7)$$

$$\begin{aligned} \left[D_I^t(y_{t+1}, x_{t+1})\right]^{-1} &= \min_{\theta,\lambda} \theta \\ s.t. -y_{ti,+1} + Y_t \lambda &\geq 0 \\ \theta x_{i,t+1} - X_t \lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \quad (8)$$

This approach can be further extended by decomposing the constant returns-to-scale technical efficiency change into scale efficiency and pure technical efficiency components. This involves calculating two further linear programs where the convexity constraint $N1'\lambda=1$ is introduced to programs (5) to (8). Using these models, and the Fare *et al*. (1994) approach, it is thus possible to provide four efficiency/productivity indices for each firm and a measure of technical progress over time. These are: (i) technical efficiency change (i.e. relative to a CRS technology); (ii) technological change; (iii) pure technical efficiency change (i.e. relative to a VRS technology); (iv) scale efficiency change; and (v) total factor productivity (TFP) change.

3. Specification of inputs and outputs

The data used in this study consists of annual observations of New South Wales local governments. All data is sourced from the NSW Department of Local Government. The time period selected is 1993/94 to 1995/96. The GDP deflator is used to deflate the monetary variables from 1994/95 and 1995/96 to 1993/94 prices. A more extensive set of time-series data would, of course, be more valuable. For example, much microeconomic reform in NSW has been implemented after 1995/96, and the last significant round of structural reform occurred in the 1970s. Unfortunately, 1993/94 was the first year in which local government accounts were prepared in accordance with the external reporting requirements of *AAS27 Financial Reporting by Local Government* and the requisite data for 1996/97 is not scheduled for release until late in calendar year 1998.

For the purposes of this study, two functions of local government are selected in order to evaluate technical and technical efficiency changes in local public services. These are: (i) domestic waste management services; and (ii) planning and regulatory services. The rationale for selecting these services is threefold. First, these services are provided by the majority of NSW local governments. Ninety-seven percent of councils provide waste management services of some form, and all councils provide planning and regulatory services. Furthermore, these services are among some of the most important functions performed by local governments in Australia. For example, the NSWDLG (1997: 28) has argued that "measuring the productive efficiency of the local approvals system is a necessary element in improving customer service, urban planning, economic, social and environmental outcomes" while the waste management services ordinarily provided by local councils (including waste minimisation strategies, collection and recycling services and land-fill disposal facilities) are an important influence upon overall environmental management performance (NSWDLG 1997). Second, the requirement to provide these services is normally imposed upon local councils, and outputs tend to be largely homogeneous, both in terms of quality and appropriateness (through minimum health standards, building codes, etc.). This enables the vectors of inputs and outputs to be kept relatively straightforward, especially as the focus is on sector-wide technical and technical efficiency changes.

Finally, the operation of these services has been one of the areas of interest for recent efforts at microeconomic reform. For instance, waste management services is one of the most frequently contracted-out services in local government. As discussed earlier, a number of legislative and administrative changes have also occurred which are likely to affect productivity in this function. These include the focus of regional organisations of councils

(ROCs) on regional waste management issues, and recent efforts at waste minimisation, as legislated by the NSW state government. Likewise, local governments' planning and regulatory function has also been the subject of recent attention. For example, several regional organisations have concluded major projects on benchmarking and best-practice in local building and planning approval processes, and legislative reviews in hand are concerned with the introduction of new planning controls, the integration of approvals with related legislation, and the clarification and consolidation of existing planning controls. The question arises to whether efforts at promoting commercialisation in some of these services, the splitting of these functions into autonomous business units, and pressures for administrative reform have prompted productivity improvements. Descriptive statistics for waste management services are detailed in Table 1, whilst those for planning and regulatory services may be found in Table 2.

Domestic waste management services

The input vector for the waste management services function consists of a single input, total collection expenditure (x_1). This measure captures most of the expenditures directly related to the domestic waste management activities of councils. The outputs are fourfold: (i) the total number of collection services (y_1) (weekly); (ii) the amount of recyclable material collected (y_2); (iii) the amount of domestic waste collected (y_3); and (iv) the implied rate of recycling (y_4). As discussed earlier, a relatively efficient council will maximise the quantity of collection services and the amount of garbage and recyclable material collected, relative to the level of collection expenditure.

Table 1 *Descriptive statistics, waste management services 1993/4–1995/96*

	Collection expenditure	Number of services	Recyclables collected (tonnes)	Garbage collected (tonnes)
1993/94				
Mean	932309	13499	1453906	13818152
Standard deviation	1316809	17010	2326711	17158433
Lowest quartile	70961	1298	0	1550000
Next to lowest quartile	291000	4843	220000	7142200
Next to highest quartile	1298060	19534	2293000	18400000
Highest quartile	7429648	68500	12157000	74270000
1994/95				
Mean	1006744	13781	1915886	13025907
Standard deviation	1418211	17329	3108139	15931045
Lowest quartile	75769	1255	0	1453560
Next to lowest quartile	299000	6072	250000	7300000
Next to highest quartile	1326000	17848	2548420	19567190
Highest quartile	6183951	70079	16999491	67836000
1995/96				
Mean	1082917	14538	2264754	12880255
Standard deviation	1492752	20648	3404026	17049178
Lowest quartile	77494	1307	6200	1235880
Next to lowest quartile	291000	5151	370400	6662000
Next to highest quartile	1516000	18617	3503421	16351500
Highest quartile	6093895	142407	16802000	87600000

Of course, a large number of factors thought to affect the efficiency of this service are excluded from the analysis. Other possible influences include the size of garbage container and frequency of collection, the type of recycling service in operation (i.e. tub, recycling facility, kerbside sorting), the disposal facilities available and the distance to these facilities (i.e. council tip, transfer station, landfill), and the use of contract labour (NSWDLG 1998). As we have seen, ignoring these 'environmental' variables may influence efficiency measurement. However, the approach selected is consistent with similar studies allowing for technical inefficiency and technological progress/regress [see, for example, Berg, Førsund and Jansen (1992), Fukuyama (1995), and Price and Weyman-Jones (1996)], especially where the panel of data is for a relatively short period. Similarly, Orme and Smith (1996: 73) have identified that the likelihood of endogeneity bias in public sector applications is very high when using DEA-based measures over time:

> [W]henever measures of the output of public sector activity receive public attention, there is a strong possibility there will be a feedback from the achieved output to the resources devoted to the activity ... particularly for units with very low levels of the endogenous resource.

Nevertheless, audited data of the type necessary to detect if such ‘feedback’ has occurred over the period in question is currently not available.

Planning and regulatory services

The inputs and outputs used in measuring the productivity of local governments’ planning and regulatory function are provided in Table 2. The inputs selected are planning and regulatory expenditure (x_1) and legal expenditure related to the planning and regulatory function (x_2). The latter input has been a subject of particular attention in recent years, especially after the Public Accounts Committee of the New South Wales Parliament expressed a concern about the high level of legal expenses incurred by councils. One problem that was identified by the Committee according to the NSWDLG (1997: 32) was:

> [T]he preparedness of a number of councils to shelve their planning management duties by encouraging any planning issue that might involve some controversy to be settled in the Land and Environment Court. Elected members were seen as making decisions without reference or concern to the costs thereby incurred by both their council and the applicant ratepayer.

The outputs selected for the analysis are twofold: (i) the number of building applications (BAs) determined (y_1), and (ii) the number of development applications (DAs) determined (y_2) (where joint applications are determined they are treated as separate BAs and DAs). Generally, the processing of these applications are the primary focus of attention for councils’ planning and regulatory function. Nonetheless, in common with the inputs and outputs selected for waste management services, a number of problems arise. One problem is that a dimension of performance ignored in these outputs is the speed at which applications are processed, especially since there has been a recent focus on “some of the operational features of the application and assessment process including fast-track mechanisms, mandatory pre-lodgement meetings, alternative dispute resolution and improved tracking and reporting on individual applications” (NSWDLG 1997: 28). However, whilst information concerning mean and median turnaround time for both BA and DA applications was available for 1995/96, it was not collected in previous years.

Similarly, there a number of other factors thought likely to affect efficiency in the planning and regulatory function that have been excluded due to a lack of reliable data. These include the nature and complexity of applications, the number of planning and regulatory staff, the degree of community consultation and notification, the level of planning and regulatory activity, the extent of referral (internal and external), and the level of scrutiny applied to inspections (NSWDLG 1997: 31). Finally, although planning and regulatory services are almost most universally offered by local governments in NSW, there are a number of councils where information was not accurately collected over the three years in question (as is also the case with waste management services).

Table 2 *Descriptive statistics, planning and regulatory services 1993/4–1995/96*

	BAs processed	DAs processed	Legal expenditure (planning)	Other planning expenditure
1993/94				
Mean	1189	445	90832	1065567
Standard deviation	1099	349	115214	1110432
Lowest quartile	407	201	0	280293
Next to lowest quartile	832	347	37307	700329
Next to highest quartile	1371	593	137870	1474000
Highest quartile	5083	1760	537440	5479000
1994/95				
Mean	1173	445	120689	1371801
Standard deviation	1088	380	214820	1331754
Lowest quartile	401	180	0	397250
Next to lowest quartile	942	345	42453	881820
Next to highest quartile	1373	541	114944	1866465
Highest quartile	5292	1867	1413000	5910000
1995/96				
Mean	1062	407	132083	1372162
Standard deviation	979	347	185453	1310801
Lowest quartile	345	179	0	398027
Next to lowest quartile	804	294	65917	855000
Next to highest quartile	1275	538	152915	1974386
Highest quartile	4450	1734	890107	6101420

Accordingly, the actual number of councils to be included in calculating the reference technology changes, and the number of separate linear programs needed to calculate the Malmquist input-based productivity indices varies across the two functions. Information on waste management services for each of the three fiscal years is provided by 148 councils (N), so that the number of separate linear programs to be calculated over the 3 time (T) periods is equal to $N \times (4T\text{-}2)$ or 1480 separate LPs. Information on planning and regulatory services is generated by 98 councils, so the number of separate LPs is reduced to 980. For the two local government functions together, 2460 separate linear programs are required.

4. Empirical results

In the previous section, we defined Malmquist indices of productivity growth relative to a reference technology. Malmquist indices for the period 1993/94 to 1995/96 are presented below for waste management services in 147 local government councils, and for 98 councils in terms of planning and regulatory services. The Malmquist index averages for each firm over the entire period are geometric means of the indices computed for each of the sample years. Using this information, three primary issues are addressed in our computation of Malmquist indices of productivity growth over the sample period. The first is the measurement of productivity change over the period. The second is to decompose changes in productivity into what are generally referred to as a 'catching-up' effect (efficiency change) and a 'frontier shift' effect (technological change). In turn, the 'catching-up' effect is further decomposed to identify the main source of improvement, through either enhancements in technical efficiency or increases in scale efficiency. Finally, we test whether differences in the various indices for different types of councils have statistical significance. This usually necessitates the use of nonparametric statistical methods, although some conventional parametric statistical tests are also reported.

Domestic waste management services

We begin by looking at the changes in productivity, efficiency, and technology for waste management services in the period 1993/94 to 1995/96. Inputs were specified in terms of total collection expenditure, and outputs in terms of the number of services, the volume of garbage and recyclable material collected, and the implied rate of recycling. No allowance was made for contextual factors (or nondiscretionary factors which may influence council waste management services). In Table 3 descriptive statistics of the indices of total factor productivity growth (TFP), efficiency change (EFF), and technological change (TEC) across groups of local governments and the state are presented. Iindices by council for each of the three years are detailed in Appendix 10. The groups are based on the NSWDLG's groupings of councils for comparative performance. These combine several of the size gradations found in the conventional ACLG classification. For example, Group 2 is composed of medium (population from 30,001 to 70,000) and small-sized (population up to 30,000) metropolitan developed councils, whereas Group 3 includes the large (population from 70,001 to 120,000) and very large (population over 120,000) subcategories. As indicated, there was a mean decrease in total factor productivity in waste management services of 2.99 percent for the period ending 30 June 1995. Given that the Malmquist index of productivity change (TFP) is a multiplicative composite of efficiency (EFF) and technological change (TEC), the major cause of productivity improvements can be ascertained by comparing the values of the efficiency change and technological change indexes.

Table 3 *Waste management productivity by group, 1993/94 – 1995/96*

Group	Index	Mean	Standard deviation	Minimum	Maximum	Group	Mean	Standard deviation	Minimum	Maximum
1	TFP	1.8380	0.0000	1.8380	1.8380	7	0.9441	0.0914	0.7480	1.0080
	EFF	2.0410	0.0000	2.0410	2.0410		1.1946	0.1058	0.9600	1.2650
	TEC	0.9000	0.0000	0.9000	0.9000		0.7899	0.0132	0.7760	0.8100
2	TFP	0.9281	0.2034	0.4840	1.2560	8	0.9970	0.2192	0.8420	1.1520
	EFF	1.1527	0.2607	0.5700	1.5880		1.2370	0.2899	1.0320	1.4420
	TEC	0.8071	0.0170	0.7760	0.8490		0.8075	0.0120	0.7990	0.8160
3	TFP	1.0184	0.1650	0.7840	1.3950	9	0.9152	0.2893	0.4670	1.6020
	EFF	1.2762	0.1953	0.9910	1.6860		1.1898	0.3683	0.5770	2.0000
	TEC	0.7975	0.0235	0.7540	0.8310		0.7744	0.0943	0.6050	0.9350
4	TFP	1.0096	0.2255	0.6080	1.5020	10	0.9393	0.2614	0.3500	1.4740
	EFF	1.2799	0.2578	0.8500	1.9070		1.1939	0.3458	0.4810	2.0230
	TEC	0.7886	0.0707	0.6160	0.8960		0.7920	0.0846	0.6520	0.9240
5	TFP	1.1380	0.2677	0.8030	1.4240	11	0.9856	0.2308	0.7520	1.5550
	EFF	1.3860	0.3335	0.9630	1.7540		1.3737	0.3345	0.9370	2.2320
	TEC	0.8223	0.0155	0.8060	0.8370		0.7221	0.0634	0.6100	0.8030
6	TFP	0.9393	0.1106	0.8410	1.0590	State	0.9701	0.2445	0.3500	1.8380
	EFF	1.1713	0.1535	1.0630	1.3470		1.2397	0.3068	0.4810	2.2320
	TEC	0.8030	0.0252	0.7860	0.8320		0.7853	0.0709	0.6050	0.9350

Notes: Groups as follows (ACLG categories): (1) UCC; (2) UDM, UDS; (3) UDV, UDL; (4) URM, URS; (5) URL, URV; (6) UFM, UFS; (7) UFV, UFL; (8) RAS; (9) RAM, RSG; (10) RAL; (11) RAV. TFP – total factor productivity, EFF – technical efficiency, TEC – technological change. Malmquist index averages are geometric means.

Put differently, the productivity losses described can be the result of efficiency decreases, technological regresses, or both. In the case of waste management services, the overall decline in productivity over the period is composed of an average efficiency increase (movement towards the frontier) of 23.97 percent, and an average technological regress (downward shift of the frontier) of 21.47 percent. However, these figures serve to obscure very different results across a number of the groups of local governments. For instance, for groups classified as ‘urban’ (including metropolitan, regional and fringe councils), there was an average positive increase in total factor productivity over the period in question.

Table 4 *Waste management productivity characteristics, 1993/94 – 1995/96*

Group	Number	Productivity		Efficiency		Source of efficiency		Technological	
		Gain	*Loss*	*Increase*	*Decrease*	*Technical*	*Scale*	*Progress*	*Regress*
1	1	1		1		1			1
2	19	9	10	14	5		19		19
3	13	7	6	12	1		13		13
4	28	12	16	25	3	12	16		28
5	4	3	1	3	1	1	3		4
6	3	1	2	3			3		3
7	7	2	5	6	1	1	6		7
8	2	1	1	2		2			2
9	31	9	22	21	10	27	4		31
10	25	9	16	21	4	16	9		25
11	14	5	9	12	2	5	9		14
State	147	59	88	120	27	65	82		147

Notes: Groups as follows (ACLG categories): (1) UCC; (2) UDM, UDS; (3) UDV, UDL; (4) URM, URS; (5) URL, URV; (6) UFM, UFS; (7) UFV, UFL; (8) RAS; (9) RAM, RSG; (10) RAL; (11) RAV.

These differences can be emphasised with reference to the characteristics of the waste management productivity growth indices contained in Table 4. As we can see, no council experienced technological progress over the period 1993 to 1996. However, 59 councils (or some 40 percent) experienced an overall gain in total factor productivity. In part, the overall gain in productivity can be attributed to the strong efficiency improvements of 120 councils (or nearly 82 percent). For the larger councils (Groups 1 to 7) these efficiency improvements have largely been the result of improvements in scale efficiency, while for smaller councils (largely rural) these have generally come from improvements in pure technical efficiency. For example, all councils categorised as 'urban developed' had an efficiency gain between 1993 and 1996 in waste management services, and for all councils this was largely the result of increases in scale efficiency. Conversely, for councils categorised as either 'rural agricultural' or 'rural significant growth', the primary source of efficiency change was the result of technical improvements, although for 13 percent of those councils having an efficiency gain, the primary influence was a scale effect.

Using the Kruskall-Wallis (one way analysis of variance) test, an effort was made to determine whether the frontier shift and catching-up effects differed statistically across local government groups. While there are no precedents in local public sector services for testing changes in Malmquist indices on this basis, several comparable studies in other industries have employed these techniques. For example, Price and Weyman-Jones (1996) have used nonparametric Kolmorogov-Smirnov tests for the purposes of analysing Malmquist indices in the privatised U.K. gas industry, and Fukuyama (1995) used Spearman's rank correlation for measuring efficiency and productivity growth in Japanese banking. The test for efficiency change using the Kruskal-Wallis test statistic [$KW = 9.900 \sim \chi^2(10)$] fails to reject the null hypothesis of equal means. However, the test for technological change ($KW = 17.446 \sim \chi^2(10)$] is asymptotically significant at the .10 level. Similar results are obtained for Kruskall-Wallis tests with the null hypothesises of equal medians for efficiency [$KW = 9.976 \sim \chi^2(10)$] and technical change [$KW = 20.369 \sim \chi^2(10)$]. This would suggest that although changes in efficiency are fairly uniform across the sample, there are statistically significant differences in the frontier shift effects. In order to further investigate this possibility, groups of councils based on the broader ACLG classification are compared on the basis of the Mann-Whitney and Kolmogorov-Smirnov nonparametric test statistics. The null hypothesis in the first instance is that the indices are equivalent in location, while in the second the null hypothesis is that the groups are equivalent in the shape and location of the efficiency distribution. On this basis, it was found that urban developed councils (Groups 1 to 3) have a significantly different distribution of frontier shift effects, whereas rural agricultural councils (including rural councils with significant growth) differ statistically in terms of total factor productivity change. Finally, the distributions of total factor productivity, efficiency, and technical change, along with local government area population, are compared on the basis of correlation. Correlation matrices for the Spearman and Kendall rank correlation indexes are detailed in Table 5. The main finding is that relative higher changes in total factors productivity over the period can be attributed mainly to improvements in efficiency, and that these are closely correlated with larger councils (in terms of population). Similar results are obtained using an ANOVA table. However, the results also indicate that there is a significant negative rank correlation between technological change and efficiency improvements.

Table 5 *Waste management correlation coefficients, 1993/94–1995/96*

	TFP	EFF	TEC	POP
Spearman rank correlation				
TFP	–			
EFF	0.912***	–		
TEC	0.188**	-0.150*	–	
POP	0.159**	0.114	0.054	–
Kendall rank correlation				
TFP	–			
EFF	0.763***	–		
TEC	0.130***	-0.109**	–	
POP	0.112**	0.079	0.046	–

Notes: TFP– total factor productivity, EFF– technical efficiency, TEC–technological change; Asterisks indicate significance (one-tailed) at the * – .10, ** – .05 and *** – .01 level.

The results show that productivity has increased in local governments' waste management function for a large number of councils over the period 1993/94 to 1995/96. This is largely due to industry wide increases in efficiency. However, the productivity improvements and the source of the efficiency change vary substantially across the sample. For example, larger councils tended to exhibit greater efficiency gains over the period, and these could be mainly attributed to improvements in scale efficiency. Conversely, for the smaller councils which experienced an efficiency increase, the primary source appeared to be improvements in technical efficiency. Despite this, councils as a whole experienced, on average, a fall in productivity of some three percent, and this is largely attributable to a contraction in the production frontier for waste management services.

Several possible influences on the degree of technological regress are hypothesised, although these are empirically untestable at the present time given the lack of suitable data. One reason is that the volume of domestic waste and recyclable materials collected is currently experiencing a general decline on a per service basis (NSWDLG 1998: 20). This reflects a general problem with measures of local public sector output that are not related to levels of 'satisfaction' or 'well-being'. However, it also indicates some of the conflicts between efficiency and effectiveness in the provision of local public services, such as waste management. For example, one objective of councils is to minimise landfill and promote the use of recycling facilities, yet the only measurable indicator of overall waste management service currently collected is in terms of volume of waste collected. Moreover, as the current analysis does not include nondiscretionary influences on these outputs, there may be a certain amount of misspecification in this indicator.

Table 6 *Planning services productivity by group, 1993/94 – 1995/96*

Group	Index	Mean	Standard deviation	Minimum	Maximum	Group	Mean	Standard deviation	Minimum	Maximum
1	TFP	1.4210	0.0000	1.4210	1.4210	7	0.7874	0.1255	0.5900	0.9700
	EFF	2.0330	0.0000	2.0330	2.0330		1.1067	0.2300	0.8610	1.4580
	TEC	0.6990	0.0000	0.6990	0.6990		0.7203	0.0765	0.5710	0.8070
2	TFP	0.9652	0.3157	0.5940	1.6280	8	N/A	N/A	N/A	N/A
	EFF	1.3206	0.4198	0.7600	2.2070		N/A	N/A	N/A	N/A
	TEC	0.7308	0.0464	0.6570	0.8100		N/A	N/A	N/A	N/A
3	TFP	0.8260	0.3457	0.4710	1.8340	9	0.6088	0.1724	0.4470	0.8500
	EFF	1.1670	0.5258	0.6200	2.7210		0.8958	0.2214	0.5980	1.1330
	TEC	0.7158	0.0536	0.6270	0.7970		0.6815	0.0795	0.5920	0.7500
4	TFP	0.7474	0.2165	0.3640	1.2980	10	0.7564	0.2320	0.3410	0.9780
	EFF	1.0819	0.3287	0.5860	2.0150		1.1889	0.3760	0.5540	1.7640
	TEC	0.6961	0.0721	0.5600	0.9200		0.6379	0.0629	0.5540	0.7360
5	TFP	0.9298	0.1471	0.7920	1.1350	11	0.8492	0.2541	0.3990	1.2400
	EFF	1.4327	0.2665	1.0370	1.6080		1.1937	0.4214	0.5670	1.8470
	TEC	0.6600	0.1114	0.5530	0.7630		0.7225	0.0539	0.6260	0.7880
6	TFP	0.8087	0.1682	0.6890	1.0010	State	0.8216	0.2654	0.3410	1.8340
	EFF	1.1260	0.2444	0.9750	1.4080		1.1757	0.3900	0.5540	2.7210
	TEC	0.7197	0.0319	0.6930	0.7550		0.7036	0.0672	0.5530	0.9200

Notes: Groups as follows (ACLG categories): (1) UCC; (2) UDM, UDS; (3) UDV, UDL; (4) URM, URS; (5) URL, URV; (6) UFM, UFS; (7) UFV, UFL; (8) RAS; (9) RAM, RSG; (10) RAL; (11) RAV. TFP – total factor productivity, EFF – technical efficiency, TEC – technological change. Malmquist index averages are geometric means. N/A – not applicable.

A second reason for the contraction of the frontier could be that the NSWDLG (1998: 19) notes that some ten percent of councils in each year of the sample were in the process of introducing recycling programs and "a further 25 percent of councils continue to provide no recycling service whatsoever". It is possible that the large input 'start-up' requirements associated with recycling programs are distorting the shape of the best-practice frontier over very short sample periods. Other factors determining the collection of recyclables could include movement in the price of recyclable materials, etc. (NSWDLG 1998). Finally, a number of technological restrictions have been placed on local governments' waste management function during this period, particularly by state governments and environmental protection agencies. These include restrictions on the use of landfill facilities, particularly in urban areas, and additional impacts related to the introduction of the NSW *Waste Minimisation Act*.

Planning and regulatory services

The Malmquist productivity, efficiency and technological indices for planning and regulatory services are presented in Table 7. In this formulation, inputs consisted of legal and non-legal planning and regulatory expenditure, and outputs were defined in terms of the number of building and development applications received and determined.

Table 7 *Planning services productivity characteristics, 1993/94 – 1995/96*

Group	Number	Productivity		Efficiency		Source of efficiency		Technological	
		Gain	*Loss*	*Increase*	*Decrease*	*Technical*	*Scale*	*Progress*	*Regress*
1	1	1		1			1		1
2	17	9	8	13	4	1	16		17
3	13	4	9	7	6		13		13
4	29	10	19	18	11	7	22		29
5	4	2	2	4		1	3		4
6	3	1	2	1	2	1	2		3
7	8	1	7	5	3	1	7		8
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	4	1	3	1	3	2	2		4
10	8	2	6	6	2	1	7		8
11	11	5	6	7	4	2	9		11
State	98	36	62	63	35	16	82		98

Notes: Groups as follows (ACLG categories): (1) UCC; (2) UDM, UDS; (3) UDV, UDL; (4) URM, URS; (5) URL, URV; (6) UFM, UFS; (7) UFV, UFL; (8) RAS; (9) RAM, RSG; (10) RAL; (11) RAV. N/A – not applicable.

As indicated, average productivity in planning services fell over the sample period by 17.84 percent, efficiency increased by 17.57 percent, and the frontier regressed by 29.64 percent. In common with waste management services, it is hypothesised that several exogenous influences have affected the production frontier over the three year period, which may, in part, be resolved by a longer sample period. Possible influences include a general downward trend in the number of BAs being determined (NSWDLG 1998: 28). However, it is also likely that the increasingly litigious nature of the planning process, and other problems associated with the reform of local governments' planning and regulatory functions, are involved in the contraction of the best-practice frontier.

Table 8 *Planning services correlation coefficients, 1993/94–1995/96*

Spearman rank correlation				
TFP	–			
EFF	0.942***	–		
TEC	0.074	-0.226**	–	
POP	0.180**	0.158	0.113	–
Kendall rank correlation				
TFP	–			
EFF	0.800***	–		
TEC	0.047	-0.154**	–	
POP	0.119**	0.106*	0.077	–
	TFP	EFF	TEC	POP

Notes: TFP– total factor productivity, EFF– technical efficiency, TEC–technological change; Asterisks indicate significance (one-tailed) at the * – .10, ** – .05 and *** – .01 level.

In common with waste management services, there has been a general improvement in planning services efficiency over the period 1993/6. However, unlike waste management services, the magnitude and distribution of these efficiency gains does not appear to vary substantially across the sample. For example, of the councils categorised as 'urban developed' (Groups 1 to 7), sixty percent experienced an efficiency gain in each of the three years and most of this gain is attributable to increases in scale efficiency. These are generally close to the overall state average [nonetheless, these results should be treated with some caution as a large number of smaller rural councils were excluded from the sample because of missing data]. The nonparametric tests statistics across the eleven groups of local governments confirms this finding. The Kruskall-Wallis test for efficiency change fails to reject the null hypothesis of equal means and medians, [$KW = 11.538 \sim \chi^2(9)$] and [$KW = 5.065 \sim \chi^2(9)$] respectively, as does the test for technological change, both mean [$KW = 13.002 \sim \chi^2(9)$] and median [$KW = 7.023 \sim \chi^2(9)$]. However, the two-group Mann-Whitney and Kolmogorov-Smirnov test statistics indicate that the locational and distributional characteristics of technical and efficiency change for urban developed councils differ statistically from the overall sample of local governments. Finally, the Spearman and Kendall rank correlation coefficients indicate that relative increases in efficiency and productivity are positively rank correlated with relatively larger councils in terms of population at the .10 level (one-tailed), and that a relatively higher technological change index is inversely correlated with efficiency gain, once again at the .10 level (one-tailed).

These results are generally consistent with those found in the earlier waste management analysis.

5. Concluding remarks

We have analysed productivity growth in New South Wales local governments' waste management and planning and regulatory functions over the period 1993/94 to 1995/96 within the framework of the DEA piecewise linear production function and the Malmquist productivity index. This allowed the simultaneous analysis of changes in best-practice due to frontier growth and changes in the relative efficiency of councils owing to movements towards existing frontiers. Overall, the results indicate that there was little or no productivity growth at the frontier during the period in question, although there was substantial improvement in the relative efficiency of nearly all councils in both functions. That productivity growth which did occur appears largely due to an increase in efficiency over the period, with improvements in scale efficiency dominating for larger, urban developed councils, and improvements in technical efficiency being notable for smaller, rural agricultural councils.

These results suffer from a number of limitations. The primary limitation is that the outputs used in the study are subject to exogenous shocks which may place councils generally in a poor light. For example, waste management outputs are defined in terms of kilograms of waste material collected, whereas planning and regulatory services include the number of building and development applications processed. Importantly, both of these indicators have exhibited a general downward trend during the sample period due to changes in domestic waste practices and a fall in building activity. More appropriate indicators of performance in these services over time may be indicators of 'satisfaction' with the service derived from consumer surveys. Another limitation is that no allowance is made to examine allocative efficiency, which may have changed during this early period of microeconomic reform. However, a more fundamental limitation is the failure to incorporate contextual factors into the analysis. This omission is largely the result of inadequate data, and means that is difficult to understand why the changes in productivity, efficiency, and especially technology, have occurred. A number of contributory factors are hypothesised, but not tested. These include changes associated with financial reform dating from 1993 (especially the adoption of accrual accounting), changes in standards placed upon local governments' waste management practices in the mid-1990s, and detailed changes to planning controls.

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