

COST EFFICIENCY OF FINNISH MUNICIPALITIES 1994-2002. AN APPLICATION OF DEA AND TOBIT METHODS*

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Abstract: *Cost efficiency of basic welfare service provision in 353 Finnish municipalities in 1994-2002 is investigated in an ongoing study. The municipal sector has a central role in the Finnish economy as a provider of welfare services. Data Envelopment Analysis (DEA), a non-parametric linear programming method is employed, calculating a best practise production frontier for the decision making units, and comparing the various DMUs with this frontier. The inputs consisted of four to ten of the most important services in health, social and educational sector. As the combined output, total real production costs of these services were used. According to the results efficiency differences were considerable between the municipalities, and a small group of a peripheral municipalities scored clearly below the others. Annual changes in cost efficiency were estimated. At the second stage, differences in the DEA efficiency scores were explained by using Tobit panel models. It was found that larger population and peripheral geographic position tend to reduce efficiency of municipal service production, while higher education level of inhabitants increases it.*

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1. Introduction

Economic efficiency of the public sector is a permanent topic of research and debate. This paper presents the first findings of an ongoing study of welfare service provision efficiency in Finnish municipalities 1994-2002. Our focus is in the relative efficiencies and efficiency differences of municipalities, as well as factors behind the differences. In Finland, a sparsely populated but geographically large country, the topic has also a regional perspective. The several outputs of the calculations are amounts of services provided, whereas an aggregate sum of expenditures is used as the input. Consequently our approach can be described as the determination of relative cost efficiency.

The structure of the paper is as follows. In section 2, the particular role of municipalities in the Finnish system of local government is described, paying some attention to the expenditure and revenue structure as well as the grant and tax equalisation system. Methods of the study, DEA and Tobit, are introduced in section 3. In section 4 data of the DEA applications is discussed, after which some preliminary findings of three estimated DEA efficiency models are presented. After this the obtained DEA cost efficiency scores are explained statistically, and results from our first Tobit models are given in section 5. Summary of the work is presented in section 6.

2. The role of municipalities in Finland

The aim of this section is to describe the role of Finnish local public sector and its relation to central government in a basically two-tier system. After a short introduction to the number and size of municipalities, the revenue and expenditure side of local governments is described. This gives an idea of the extensive tasks of local governments in Finland. We also summarise some key features of the tax and grant reforms, which have taken place during the period we study in subsequent sections.

2.1 The number of municipalities

The structures of government differ across countries, which is partly understandable on the basis of their size differences. There are federal countries, which tend to be big in population, but they also include Austria and Belgium. Most countries, including unitary countries, typically also have an intermediate level with taxing powers. This is also true for Nordic countries except Finland with only two tiers. This is noteworthy, as the provision and typically also the production of a wide range of public services has been decentralised to municipalities in Finland. In the other Nordic countries the intermediate level is responsible e.g. for much of health care, part of education and infrastructure whereas in Finland this level with its own tax powers and decision making units does not exist. Finland, with its 5 million people has roughly the same amount of municipalities relative to population as Norway, but three times as many as Sweden and Denmark. The number of municipalities in Great Britain and Finland is roughly the same although there are more than ten times people in Great Britain than Finland. This indicates great variability in the average size of municipalities.

Because there are a lot of small municipalities in Finland and their tasks are broad and expensive, they co-operate in different ways. In 2000 there were 226 joint organisations of municipalities, such that two or more of them provided jointly some services (e.g. health services and education). These organisations can be seen as an alternative to mergers if cost efficiency of service provision depends on the scale of activities.

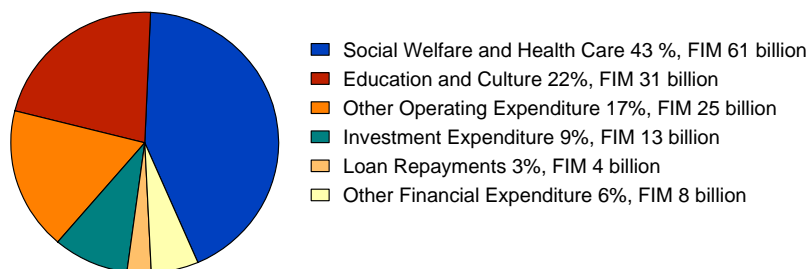
Increasing the size of municipalities by mergers is often suggested by some discussants. Some mergers have taken place recently, and some more are planned, but the numbers are small. The basic argument for mergers is economies of scale. The most common argument against them is loss of local democracy. The arguments for many competing municipalities in an area are rarely heard, as well as the fears of inefficiency in big “local monopoly” governments.

2.2 The expenditure and revenue structure of Finnish municipalities

In 2000 total expenditure of the public sector in Finland were about 49 % of GDP. Local public sector’s (municipalities and their joint organisations) respective share of GDP was about 18 %, i.e. one third of total public sector expenditure. The main activity of central government and social security funds is in transfers, whereas the local public sector concentrates on services. Over 80 % of employees in the municipal sector worked in social, health and education services.

The expenditure of local authorities and joint municipal authorities makes up nearly two-thirds of all public expenditure on consumption and investments in Finland. A breakdown of total municipal sector expenditure in 1998 is given in Figure 1. Most of the expenditure of local authorities and joint municipal authorities arises from the provision of basic community services, such as social services and health care, education and cultural services, infrastructure maintenance and environmental protection.

Figure 1: Total municipal sector expenditure, 1998



Taxes, government grants and fees are the key items in financing local governments. Emphasising the role of local self-government Finnish municipalities have (relatively) independent taxation rights by which local authorities finance nearly half of their operations. Finland has a two-tier system and, on the other hand, the taxing power is in the hands of municipalities whereas joint municipal authorities have no taxing powers of their own. Municipalities levy a local income tax and a property tax on residential and non-residential real estate. In addition, they receive an annual share of the revenues from corporate taxes. Each municipality decides independently on its income tax rate; no upper limit is set. In 1998, the average local income tax rate was 17.5 % of taxable income, the lowest tax rate being 15 % and the highest 19.75 %. Although the municipal income tax rate is set locally, the tax base is affected by nationally applying tax allowances decided by the government.

The property tax, to be paid by property owners irrespective of where they reside, was introduced in 1993. The municipal council decides tax rates within statutory ranges for at least two types of real estate: a general property tax rate (0.50-1.00 %) and a rate for buildings used as permanent residences (0.22-0.50 %). Out of all tax revenue in 1998, the share of property tax was 4 %.

Before 1993 municipalities could tax corporate income directly - the tax rate for corporate income was the same rate that was locally decided for personal income. Due to the tax reform of 1993 corporate income was taxed with a fixed 25 % national rate. In 2000 the corporate income tax rate is 29 %. A share of the accrued corporate income tax is then paid to municipalities by portions that are fixed in the Income Tax Law.

2.3. The grant and tax equalisation system in Finland

Grants (state subsidies) from the government accounted for less than 20 % of total municipal sector income in 1998. This amount is the sum of grants and the outcome of the tax equalisation system. The share of grants in the revenue structure of municipalities has decreased during the 1990s. They covered 50 % of net operating expenditure in 1993, whereas in 1998 they covered only 24 %.

In 1993, the grant system for municipalities' operating expenditures was altered so that the grants began to be based on so called "calculated expenditures". In practice this meant that the unit costs of the municipal services were estimated yearly by the associated ministries. Based on the estimated expenditures, the grants were then calculated and paid to each municipality as non-matching block grants. The purpose of the reform was to simplify the system and to give the municipalities an incentive to act cost-effectively.

All things considered, the change in the grants system in 1993 was remarkable: from a system with nearly 99 % of the grants matching to a system where all grants were non-matching block grants. Although there was a transition phase until 2002 the effect on many municipalities was radical. In addition, due to economic recession, the central government had to cut the grants throughout 1993 – 1996. During this period the grants were cut altogether by 10 billion FIM. On the other hand, at the same time the municipalities' tax incomes increased approximately 15 billion FIM so the municipal sector was on average able to improve its financial position.

But the cuts affected a number of individual municipalities severely. The way the cuts were made differed almost every year and depended on the purpose of the grant. For instance the health and welfare grants were cut per capita in 1993, but in 1994 they were cut so that 40 % of the reduction was made on a per capita basis and 60 % depended on the municipality's tax base. In 1995, the cuts were made by lowering the unit costs used in calculating the grants, and in 1996 the cuts were made again on a per capita basis. As a result of the variety of the methods used in cutting grants, it is almost impossible to define how the cuts have affected different municipalities. It seems, however, that the cuts were most severe in the municipalities with largest populations.

The last major grant reform took place in 1997 with the aim to revise the criteria for social and health care, education and culture grants. The new system is made up as before of general government grants and two sector grants to social welfare and health care and education and culture. The 1997 reform of the grant system included a revision of the criteria for sectoral grants. Each local government gets a sum of calculated expenditures, and from these calculated expenditures is deducted the municipal financing share that is the same for all local governments. The result is the grant share (grant per capita multiplied with the number of inhabitants) of expenditure need.

The general grants are formed from grants per capita and tax revenue equalising grants (or payments). The *grant per capita* consists of basic amount and supplements that take into account the special conditions of the municipalities: bilingualism, island municipality, remoteness and high population density.

In the tax base equalisation system the tax equalisation limit is 90 %. The sum by which a municipality's tax units/inhabitant figure falls short of the equalisation limit of 90 % of the mean tax base per inhabitant is paid to the municipality multiplied by the number of inhabitants and average tax rate. If the municipality has a tax base and calculated tax incomes per inhabitant over 90 % of the equalisation limit, it must pay 40 % of the difference between its tax base and equalisation limit. If the municipality has even over 144 % it must pay only 15 % of the tax base over the 144 % limit. In practise all grants, except those given to service providers which are not municipalities, are lumped together (net of equalisation payments) and as such the sum is not earmarked to any specific use.

3. Methods of the study

3.1. Data Envelopment Analysis

Data Envelopment Analysis (DEA), our non-parametric linear programming method of measuring (in)efficiency is fundamentally based on the work by Farrell (1957) which was further elaborated by Charnes et al. (1978) and Banker et al. (1984). This approach (see e.g. Färe et al. 1985) has been widely used in empirical efficiency (or productivity) analysis especially in cases where the units (DMUs) use multiple inputs to produce multiple outputs, and there are problems in defining weights and/or specifying functional forms to be employed in analysis. As DEA does not require input or output prices in determining empirical efficiency frontiers based on best practise technology and related measures of inefficiency, it has become especially popular in the study of public sector. These applications include efficiency studies concerning e.g. schools, hospitals and theatres, also private sector applications have been numerous as can be seen e.g. from Seiford and Thrall (1990).

Several DEA studies of public sector efficiency have also been made in Finland. Kirjavainen and Loikkanen (1993, 1995, 1998) and Kirjavainen (1999) employed the method to investigating efficiency differences between senior secondary schools. Linna (1999) used the method to measuring Finnish hospital performance, employing also Malmquist indexes, while Luoma and Järviö (2000) studied productivity of health centres. In addition efficiency of government employment agencies (Martikainen 1994) and municipal courts Niemi (1994) have been studied.

Internationally, some studies have assessed the aggregate efficiency of local public sectors. Attempts have been made to assess to what extent inefficiency arises from factors beyond the control of the decision units, and how much is due to inadequate management of productive resources. Balaguer-Coll et al. (2002) study this problem with respect to Spanish local governments while Worthington and Dollery (1999) focus on New South Wales. De Borger and Kerstens perform a comparative analysis of several non-parametric and econometric approaches in their analysis of Belgian local governments. Other non-parametric applications include DeBorger et al (1994), applying the free disposal hull technique to Belgian municipalities, as well as the work of Balaguer-Coll et al (2003), employing activity analysis to Valencia.

In his article on the strengths and weaknesses of DEA in regional applications, Stolp (1990) gives five important features of the method:

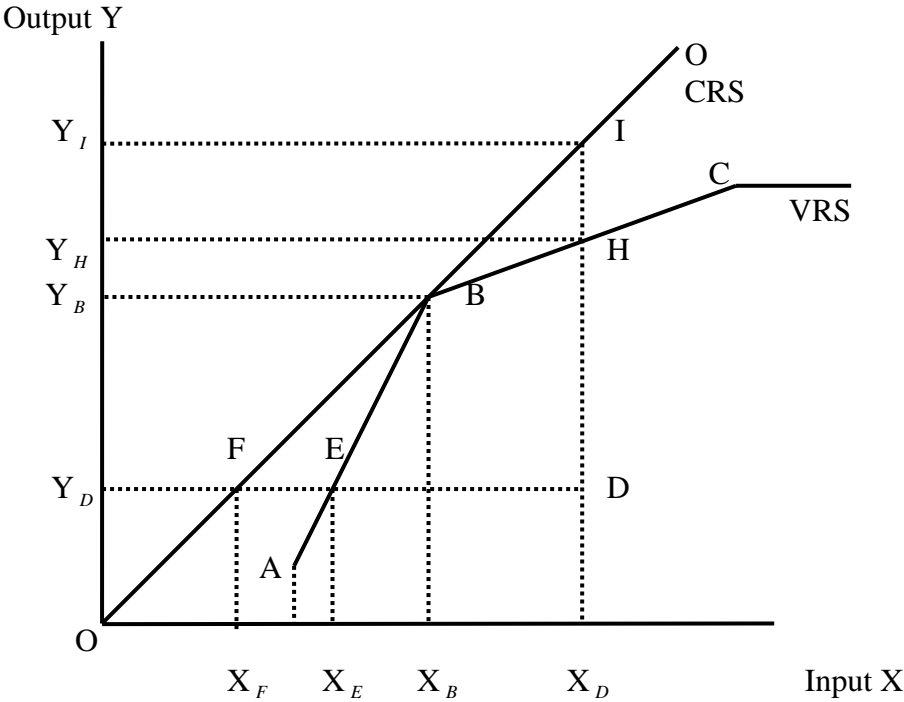
1. DEA can accommodate production relations involving multiple outputs. Its central logic is a generalisation of the simple output-to-input ratio efficiency measure.
2. DEA estimates the technical efficiency frontier. Rather than summarising the central tendency of the sample, it identifies the DMUs that represent the "best revealed practise", given weak assumptions about the monotonicity and concavity of the production process.
3. DEA identifies for each inefficient DMU a set of relatively efficient referent DMUs with a similar production structure, and estimates a relative efficiency score for each DMU.
4. DEA suggests how to reallocate inputs/outputs in order to achieve technical efficiency.
5. DEA can evaluate DMUs in terms of the local nature of returns to scale.

Critics of the method have brought up two main points. The first concerns DEA's nature as a "less-than-full-information statistical tool" in the sense that the location and shape of the estimated production surface is determined solely by the most efficient observations. Secondly, DEA is essentially a non-stochastic method. For a discussion on these, see Stolp (1990). To keep this paper short, we shall not present mathematically the linear programming background for DEA. We will instead graphically describe a basic case of the method.

Four decision making units are described in Figure 2 below; these are the points A, B, C and D. The DMUs use one input X to produce one output Y. Either constant returns to scale (CRS) or variable returns to scale (VRS) can be assumed for the production possibility frontier. In practical research several inputs and/or outputs are used, creating a multidimensional situation.

Under CRS, the most efficient unit is B, for which the tangent of the angle measured from the origin (output/input) is greatest (Y_B / X_B). Accordingly, the efficiency frontier under CRS is the line OO. Compared with B, points A, C and D are clearly inefficient. Point D for example uses more of the input (X_D) to produce less of the output (Y_D) than point B. In order to be efficient, only X_F should be used to produce Y_D , or alternatively Y_I should be produced with input use X_D . From this we get X_F / X_D as the relative efficiency of D in the input direction; in the output direction the efficiency score is Y_D / Y_I . Under CRS these two ratios are equal, or $(X_F / X_D) = (Y_D / Y_I)$.

Figure 2. Efficiency of decision making units in DEA, basic case



Under VRS the efficiency frontier passes through the points A, B and C. Consequently the relative efficiency of D is X_E/X_D in the input direction and Y_D/Y_H in the output direction, these ratios being generally unequal. In VRS efficiency can be further decomposed into scale efficiency and technical efficiency. Scale efficiency relates the size of the DMU to optimal size; in the input direction it is given by the ratio (efficient input use under CRS)/(efficient input use under VRS), or X_F/X_E in figure 2. Similarly, scale efficiency in the output direction is Y_H/Y_I . This efficiency loss is due to the inoptimal size of the DMU. The rest of the inefficiency of D is technical inefficiency, measured by X_E/X_D in the input direction, or Y_D/Y_H in the output direction.

Finally, the change in total factor productivity of each DMU can be calculated in DEA, using the Malmquist index approach. This change can be further decomposed into the change in the relative position of the DMU with respect to the efficiency frontier (PPF), and to the movement of PPF itself. For this, see Cooper, Seiford and Tone (2000).

This article confines to some basic results on DEA efficiency, also assuming constant returns to scale throughout.

3.2. Explaining (in)efficiency by Tobit models

Tobit models were applied to explain the DEA (in)efficiency differences between municipalities, obtained in the first part of the study. As a result of cross-sectional DEA calculations with annual data for 1994-2002 we obtained efficiency scores for each municipality in each year. In each year fully efficient regions (at least one) got an efficiency score equal to one (100 %) and inefficient ones below one (below 100 %). In this preliminary paper we will confine ourselves to some basic models with a few explanatory variables only. For this purpose we first define inefficiency score I as

(1) Inefficiency score = 1 - efficiency score

and define the dependent variable (Y) in Tobit model in two alternative ways. First, defining Y to be equal to I, which is equal to censoring it to a lower limit zero (i.e. $I = 0$). In this case only fully efficient regions have $Y=0$ value. Alternatively in this paper we censor all regions with $I \leq 0.07$ to Y value= 0, and otherwise $Y = I$. This means that we form a group of efficient regions by the criterion that efficiency score is at least 93 % (inefficiency at most 7 %). First results of both the uncensored and censored case are presented in chapter 4.

In both cases the standard Tobit model (see e.g. Maddala 1983) can be defined as

$$(2) \quad \begin{aligned} Y_i^* &= X_i \beta + \mu_i \\ Y_i &= Y_i^*, \text{ if } Y_i^* > 0 \\ Y_i &= 0, \text{ otherwise.} \end{aligned}$$

Above, X_i is a vector of explanatory variables, i refers to municipality and β is a vector of parameters to be estimated. Y_i^* is a latent variable which can be viewed as a threshold beyond which the explanatory variables must affect in order for Y_i to “jump” from 0 (here being efficient) to some positive value (being inefficient in various degrees). The Tobit model can be estimated by the maximum likelihood method by assuming normally distributed errors μ_i .

Even though there are many efficient municipalities each year, the number of always efficient municipalities is small, as the relative positions of municipalities change during the study period

As for the explanatory variables in Tobit panels, we used the following variables:

- size of the region was measured by total population, with the purpose of catching potential positive or negative scale effects in municipal service production.

- education level of the inhabitants is a factor assumedly connected positively with efficiency. It was measured by average years of education of adults (multiplied by 100); alternatively the share of students in the population (university and/or vocational college), as well as having a university in the region were tried.

- population structure is likely to affect the cost structure of services. Two explanatory factors were tried, namely the share of foreigners and the share of very old people (over 85 or 90 years of age). Both were assumed to raise service costs and decrease efficiency.

-a distance variable was used to inversely measure domestic economic accessibility of the regions. It was calculated by weighting the road distances of each respective region (83 NUTS 4 economic regions) to all other regions by the value added of the destination regions. A peripheral location was assumed to decrease efficiency in public service production. In addition a dichotomous local distance variable was applied, indicating whether the municipality is the largest centre in its own region.

-finally, two alternative indicators of economic structure of the functional regions were used, to take into account the possible connection between this structure and (in)efficiency. Of these, the share of ICT services in the region's economy was assumed to correlate positively with efficiency, whereas the general extent of regional specialisation (measured from sectoral value added by the Herfindahl index) might either increase or decrease inefficiency.

4. DEA calculation of cost efficiency of municipalities in Finland 1994-2002

4.1. Data and models

It is the aim of the study to cover the 448 Finnish municipalities as comprehensively as possible, but data reliability made it necessary for us to restrict the sample. The archipelago province of Ahvenanmaa (Åland) has been omitted, as its figures are not comparable enough to the rest of the country. Secondly, municipal accounting in Finland tends to be less developed in smaller communities, causing potential reliability problems. For this reason, municipalities of less than 2000 inhabitants (5000 in model 3, see below) were excluded. The third group of excluded cases consists of those municipalities which faced a municipal annexation during the study period. The final sample consisted of 353 municipalities (212 in model 3), out of the total of 448 municipalities.

At the first stage of the study three different DEA efficiency models were estimated for the separate years 1994-2002. The outputs were as follows:

Table 1. Outputs of municipalities in the three DEA models

Output	Model 1	Model 2	Model 3
Children's day care, annual sum of days:			
1. – in day care centres	x		x
2. – in family day care	x		x
3. -combined		x	
4. Institutional care of the elderly, sum of days	x		x
5. Institutional care of the handicapped, sum of days			x
6. Open basic health care, number of visits	x	x	x
7. Nursing days at bed wards in basic health care	x	x	x
8. Dental care, visits			x
9. Hours of teaching in comprehensive schools			x
10. Hours of teaching in senior secondary schools	x	x	x
11. Total loans of municipal libraries			x

For health care and social services sectors, the outputs include services provided to inhabitants of the municipality (own service production of the municipality minus services sold outside plus services purchased by the municipality from other producers). For schools and libraries data was only available on municipalities' own service production. For comprehensive schools and libraries the difference between the two approaches is likely to be small. However, many small municipalities buy their senior secondary school services from outside organisations. This problem was tackled by excluding the smallest municipalities from the data.

As inputs, total sum of expenditures related to the above mentioned outputs were used. The expenditures were deflated by the general cost index of the municipal sector. A proportional share of the general administration costs of the respective main municipal activity sectors (health, social services, education and culture) were added to the expenditures.

4.2. DEA efficiency results

Table 2 shows some aggregate figures of the estimated DEA models. Different models give different variation ranges for the results, as could be expected:

Table 2. Average results from three basic DEA models 1994-2002

	Model 1	Model 2	Model 3
Average number of efficient municipalities in data	37	13	75
Number of always efficient municipalities	3	1	13
Median efficiency	0.890	0.836	0.966
Lowest efficiency	0.613	0.570	0.662
Number of outputs	6	4	10
Number of inputs	1	1	1
Number of municipalities in sample	353	353	212
Lower limit of population in sample	2000	2000	5000

In Figure 3 the efficiency distributions given by the three models are presented by ordering the municipalities by decreasing relative cost efficiency. Differences between municipalities are fairly large in models 1 and 2. In model 3 the variations are smaller, which is due to the greater number of variables. The steepness of the tail of the distribution (the most inefficient municipalities) is an obvious feature in all the three models. The steep section of the curves concerns in each model 10 to 15 municipalities, which largely tend to be the same units. Almost all of these weakest municipalities are rural communes in Northern Finland, mostly in Lapland. Whether these tails of the distributions are due to real weakness of performance or caused by data defects is a question to be solved.

Figure 3. Efficiency scores of municipalities in decreasing order, three DEA models, average percentage scores for 1994-2002

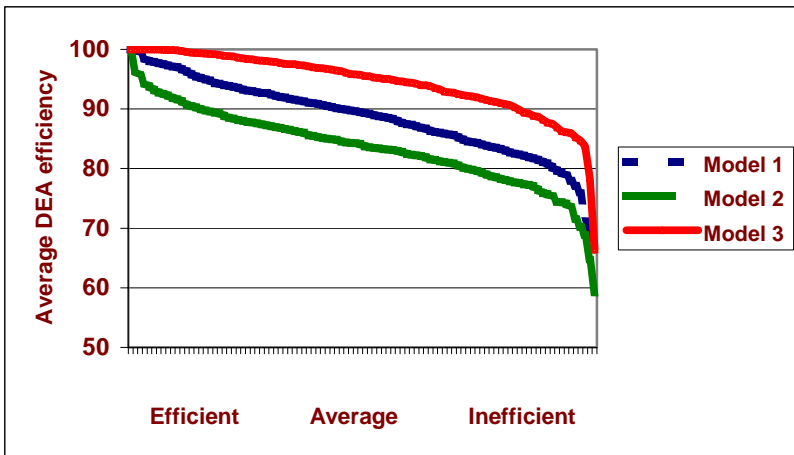


Figure 4. Annual median efficiency of municipalities in three DEA models

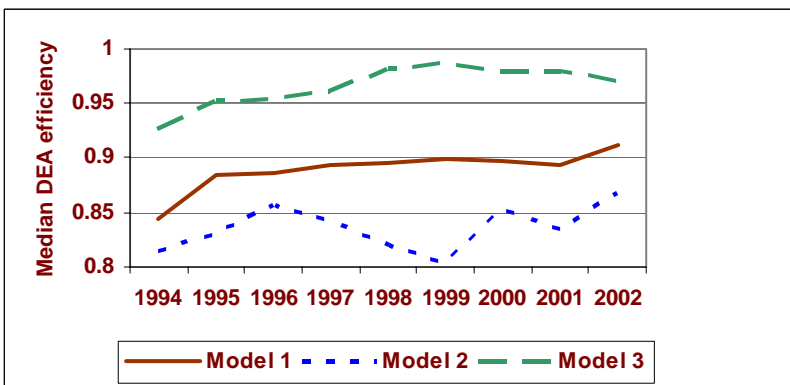
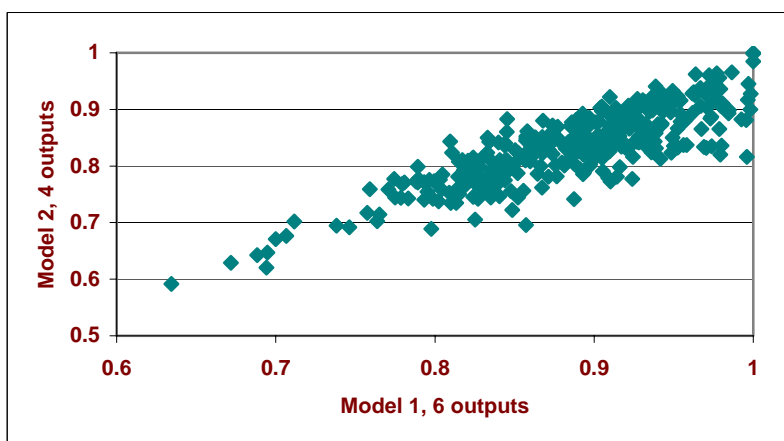


Figure 5. Efficiency scores for two DEA models



Median efficiency also varies clearly between the models (Figure 4). The high median values of Model 3 limit its usefulness in further analysis. Another distinctive factor between the models is the different development of median values in 1997-1999.

Correlation coefficients of average DEA cost efficiencies of the municipalities given by the three basic models were reasonably high, ranging between +0.799 and +0.842 between the models. Figure 5 shows average efficiency scores for the municipalities for models 1 and 2. A small number of municipalities with notably low scores are again noted. Comparing models 1 and 2 it is seen that increasing the number of variables tends to raise efficiency scores, a built-in feature of DEA. However this is not necessarily the case in Figure 5 as a slight difference exists in the outputs of the models. In particular some municipalities with an efficiency score close to average in model 1 get a markedly lower position in model 2.

Table 3. Annual Malmquist cost efficiency change in municipal welfare services in Finland 1994-2002, three DEA models, per cent*

	Model 1	Model 2	Model 3	Average of M1 – M3
1994 – 1996	+3.4	+4.0	+3.2	+3.5
1996 – 1999	-0.4	+0.1	-0.2	-0.2
1999 – 2002	-3.4	-0.5	-0.8	-1.6
1994 – 2002	-0.6	+0.8	+0.4	+0.2

*Municipalities weighted by total population

Total cost efficiency change figures in the three sub-periods of table 3 look reasonable and the models are fairly close to each other, with the exception of model 1 in 1999-2002. The large productivity growth figures for 1994-1996 are sensible, as these years were exceptional in the Finnish economy. This period witnessed the first years of recovery from a deep recession, which was also felt in the public sector as increasing demand for efficiency. The negative figures for 1999-2002 however look somewhat alarming, considering the costs and future of public services production.

5. First results of explaining efficiency differences with Tobit panel models

At the second stage of the study, models 1 and 2 above were chosen to further analysis. The third model, consisting of 212 municipalities and ten outputs was discarded because of small variation in efficiency scores. Both uncensored and censored Tobit specifications of the two models were estimated. In the censored Tobit panels all municipalities with DEA efficiency rate above 0.93 (inefficiency below 0.07) were considered efficient, in addition to which a lower efficiency limit of 0.3 was applied.

Table 4. Explaining DEA inefficiency variations of Finnish municipalities 1994-2002, four Tobit random effects panels

	Uncensored models				Censored models*			
	Model 1		Model 2		Model 1		Model 2	
	coeff.	z-ratio	coeff.	z-ratio	coeff.	z-ratio	coeff.	z-ratio
Population, 1000 inh.	0.0004	6.94	0.0005	8.74	0.0004	4.24	0.0005	8.82
Education level of population, av.years	-0.108	-12.83	-0.056	-7.06	-0.123	-14.41	-0.066	-8.05
Economic distance of region, 100 km	0.022	9.13	0.022	12.33	0.023	11.05	0.021	11.76
Position of municipality in region	-0.003	-0.65	0.001	0.12	-0.002	-0.28	0.006	0.68
Population share of foreigners, %	-0.004	-0.99	-0.003	-0.84	-0.003	-0.82	-0.003	-0.70
Herfindahl specialisation index	0.061	2.41	0.095	2.93	0.056	1.43	0.093	2.61
Constant	0.337	13.70	0.248	9.89	0.374	14.95	0.267	10.97
Total number of observations	3177		3177		3177		3177	
Left-censored observations	315		113		972		400	
Right-censored observations	0		0		0		0	
Number of municipalities	353		353		353		353	
Rho	0.552		0.495		0.548		0.499	
Log-likelihood	3753.47		3986.68		2505.49		3457.02	

*With lower censoring limit 0.07 and upper limit 0.7.

In all cases higher population of municipality would bring higher inefficiency. Considering that DEA efficiency scores vary in practice between 0.5 – 1.0, the population effect would in practise be detrimental for the largest municipalities (an increase of 100 000 inhabitants is connected with a decline in DEA score of 0.04 to 0.05). But as to the smaller municipalities forming the large majority of cases, population would not much differentiate between their efficiencies. Another question is whether a non-linear specification should be chosen for a population effect. Preliminary estimations did not support nonlinearity, but further analysis will be performed later.

Of the other explanatory variables, higher education level of regional population tends to reduce inefficiency considerably. Average years of education vary within about one year between municipalities. Consequently the efficiency differences accounted to education level differences would be somewhere between 0.05 and 0.13 at maximum. As to distance, general economic peripherality affects efficiency of municipal services adversely, whereas the position of a municipality within its economic region seems to have no effect. Having a more specialized regional economy is to some extent connected with lower efficiency. On the other hand having a larger share of foreign population is not connected with the DEA efficiency scores, which may sound surprising considering eventual service production costs.

As to potential explanatory factors not included above neither the share of students in regional population nor having a university in the region had an effect on efficiency. As to economic structure, a large amount of ICT services available in the region was expected to reduce inefficiency. However, value added shares of these services did not produce the expected result, and in some cases even unexpected signs were obtained. Thirdly, population share of people over 85 or 90 years was considered, assuming that in this population group the share of expensive health care

operations might increase, also increasing cost level and DEA inefficiency. Neither did estimations support this assumption. This may partly be explained by the fact that institutional care for the aged is already included as a separate output in the DEA estimations part, taking account of the effect.

Several explanatory factors should still be added to the panel in order to make it more realistic. Differences in regional wage levels are likely to affect adversely DEA cost efficiency of larger cities, particularly in the Helsinki region. Variations in social and demographic structure may alter the shares of low- and high-cost services, affecting relative positions of municipalities. Also the range of actual services provided within a certain statistical item is likely to vary, producing cost differences. Finally, competency and age-structure of municipal employees are likely to differ.

6. Summary

The cost efficiency of welfare service production in Finnish municipalities 1994-2002 was studied in this paper. A two-stage procedure was applied. At the first stage, annual relative efficiency scores were estimated for 353 municipalities with the DEA method. Three alternative constant returns to scale models were used. The outputs consisted of four to ten most important services in the health, social and educational sector, and combined production costs of these services were used as the input. Considerable differences exist between municipalities, a group of peripheral Northern Finland municipalities lagging behind others in efficiency. Reasonably high correlation coefficients prevailed between results of the three models, although relative positions of single municipalities may vary greatly.

At the second stage of the study, differences between DEA efficiency of the municipalities were statistically explained with Tobit random effects panels. As explanatory factors, variables describing total population, population structure and education level of the municipality, together with regional measures of accessibility and economic structure were used. Larger population was seen to reduce relative efficiency of municipal services. A more peripheral location of the functional region has the same effect, but position of the municipality in its own functional region was unimportant. A higher general education level of the inhabitants raises efficiency, but having a university or a large number of students in the region had no effect. A diversified regional economic structure tends to be connected with higher efficiency to some extent. Interestingly, population structure factors like the shares of foreigners or very old people produced no effect in the Tobit models.

The results are quite preliminary, and during the coming stages of this ongoing study the research procedure will be re-worked to some extent. More detailed service output data is needed for the DEA estimations, in particular to differentiate between low-and high cost health services. Secondly, the outputs should be weighed in the DEA scoring process in some way. One possibility is to use unit costs to set limits to the relative weights of the most important outputs. Thirdly, the panel methodology should be refined, to take into account problems caused by restricting the dependent variable to the [0,1]-range. More explanatory variables are also needed for the panel analysis.

References

- Balaguer-Coll, M. – Prior, D. – Tortosa-Ausina, E. (2003): On the Determinants of Local Government Performance: A Two-Stage Nonparametric Approach. University of New South Wales, Centre of Applied Economic Research, Working Paper.
- Balaguer-Coll, M. – Prior-Jimenez, D. – Vela-Bargues, J. (2002): Efficiency and Quality in Local Government Management. The Case of Spanish Local Authorities. Universitat Autònoma de Barcelona, Documents de treball 2002/2.
- Banker, R.D. - Charnes, A. - Cooper, W.W. (1984): Some models of estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, Vol. 9, No. 9, 1078-1092.
- Charnes, A., Cooper, W.W. and Rhodes, E. (1978): Measuring the efficiency of decision making units. *European Journal of Operational Research*, Vol. 2, 429-444.
- De Borger, B. – Kerstens, K. (1996): Cost Efficiency of Belgian Local Governments: A Comparative Analysis of FDH, DEA and Econometric Approaches. *Regional Science and Urban Economics*, 145-170.
- De Borger, B. - Kerstens, K. – Moesen, W. – Vanneste, - J. (1994): Explaining Differences in Productive Efficiency: An Application to Belgian Municipalities. *Public Choice* 80, 339-358.
- Färe, R. - Grosskopf, S. - Lovell, C.A.K. (1985): *The Measurement of Efficiency of Production*. Boston: Kluwer-Nijhoff.
- Karhu, V. - Rentola, P. – Soronen, M. (1999): *Kunnat puun ja kuoren välissä*. University of Tampere, kunnallistieteiden laitos. Publication 2/1999, in Finnish.
- Kirjavainen, T. (1999): "Efficiency of Finnish Senior Secondary Schools: Explaining High and Low Performance with Resources, Environmental, and Organizational Factors. Helsinki School of Economics and Business Administration, Working papers W-221.
- Kirjavainen, T. - Loikkanen, H. (1993): *Lukioiden tehokkuuseroista*. Valtion taloudellinen tutkimuslaitos, tutkimuksia 16, Helsinki.
- Kirjavainen, T. - Loikkanen, H. (1995): *School Resources and Student Achievement: Evidence from Finnish Senior Secondary Schools*. Valtion taloudellinen tutkimuskeskus, Discussion Papers 91, Helsinki.
- Kirjavainen, T. - Loikkanen, H. (1998): Efficiency Differences of Finnish Senior Secondary Schools: An Application of DEA and Tobit-Analysis, *Economics of Education Review*, Vol. 17, No 4.
- Linna, M. (1999): *Measuring Hospital Performance: The Productivity, Efficiency and Costs of Teaching in Finnish Hospitals*. Stakes, Research report 98, Jyväskylä .

- Luoma, K. – Järviö, M-L. (2000): Productivity Changes in Finnish Health Centres: A Malmquist Index Approach. Valtion taloudellinen tutkimuskeskus. Discussion Papers 218, Helsinki.
- Maddala, G.S. (1983): Limited-Dependent and Qualitative Variables in Econometrics. Econometric Society Monographs No. 3. Cambridge University Press.
- Martikainen, M. (1994): Työvoimatoimistojen tehokkuus 1992-1993. Valtion taloudellinen tutkimuskeskus, keskustelualoitteita 79, Helsinki.
- Niemi, M. - Luoma K. - Sarho R. - Östring T. (1994): Alioikeuksien tehokkuuserot Suomessa vuonna 1991. Valtion taloudellinen tutkimuskeskus, keskustelualoitteita 72, Helsinki.
- Seiford, L.M. and Thrall, R.M. (1990): Recent Developments in DEA. Journal of Econometrics, Vol. 46, 7-38.
- Stolp, C. (1990): Strengths and weaknesses of data envelopment analysis: an urban and regional perspective. Computers, Environment and Urban Systems, Vol. 14, No. 2, 103-116.
- Worthington, A. – Dollery, B. (1999): Allowing for Nondiscretionary Factors in Data Envelopment Analysis: A Comparative Study of NSW Local Government. University of New England, School of Economic Studies, no. 99 – 12.