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Efficiency in the Provision of Municipal Nursing- and Home-Care Services: The Norwgian Experience

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EFFICIENCY IN THE PROVISION OF MUNICIPAL NURSING- AND HOME-CARE SERVICES: THE NORWEGIAN EXPERIENCE[t]

by

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ABSTRACT

The municipalities in Norway are responsible for providing care for their inhabitants in need. The care takes two main forms: institutionalised care in nursing homes and home-based care. Based on cross-section data for 1995 for 471 municipalities the efficiency of the care activity is investigated using the non-parametric DEA approach. Quality is regarded as very important for the amount of resources spent, but measures that capture quality are very hard to come by. The available data source allows only single-bed rooms as a quality indicator for nursing homes and only number of clients in various age groups as basis for output variables in general. For the three basic activities nursing homes, home based care and home based medical treatment nine output variables are defined based on three age groups; 0-17, 18-79, and 80+. The forming of age groups are designed to reflect the severity of need for care in order to take care of the "patient-mix"- effect. In addition, net throughput of clients as a variable catching short-term clients in nursing homes is used as an output. Labour in man-years and other current expenses are the inputs. There are no data for capital inputs, like buildings and equipment. Significant differences in efficiency between municipalities are revealed and efficient peers identified that can be studied by municipalities wanting to improve performance.

KEY WORDS: Nursing, Home care, Efficiency, DEA

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[t] The paper is part of the project "Cheaper and better?" financed by the Norwegian Research Council, and is a continuation of the project "Efficiency and quality variations in the provision of municipal nursing-and home care services" financed by the Municipalities' Association (see Erlandsen et al., 1997).

JEL CLASSIFICATION: D24, H42, I12, L84

1. **Introduction**

Municipalities of Norway are, by law, responsible for provision of care of persons in need, due to old age or physical and psychological handicaps, etc. The care can take place either in institutions or in peoples' homes. This is public sector production, with a few private not-for-profit institutions, and the most important municipal spending sector consuming about 25 per cent of the total budget. The services of the sector are not traded in a market. There is therefore neither an automatic check on the efficiency in the use of resources, nor on the match between services demanded and type of services provided. The purpose of the paper is to explore the potential for improvement as to the former aspect by using observed best practice as a norm for efficient operation (but see Newhouse (1994) for a critique of a frontier approach in the health sector). A nation wide cross-section study is undertaken for the first time in Norway, with municipalities, and organisational independent sub-regions within the three largest cities, as the units. Earlier studies for Norway have been focussed on institutions within a limited region, e.g. for the largest cities. Home based care has not been included in any efficiency studies before in Norway. And also internationally the focus has been only on institutions, like nursing homes (see e.g. Chattopadhyay and Ray (1996), Dusansky and Wilson (1994), Kooreman (1994), Nyman and Bricker (1989), Rosko et al., 1995). This study will include both institutionalised- and home care. Institutions within a municipality will be aggregated, while the home care sector is run as one unit within each municipality (or sub-region). The underlying adopted technology is that the multiple outputs of institutionalised- and home based care services are provided with the use of resources (i.e. resources are not allocated the two types of basic activities). Thus, we do not address whether institutionalised- or home based care is the most efficient. The efficiency is in principle independent of the split of users between them.

There is much concern about quality of the care services provided. However, operational measures of quality are impossible to get at this stage. We have utilised existing data that has recently been gathered on a nation-wide scale.

The outline of the paper is as follows: In Section 2 we will discuss the nature of service production in general, and how quality can be defined in principle, and point to possible operationalisations. In Section 3 the DEA method for calculating efficiency scores is presented briefly together with the definitions of the efficiency measures. The data and definitions of variables are presented in Section 4, and the results set out in Section 5. Concluding remarks and suggestions for further research are offered in Section 6.

2. Theory of service production

Definition of service production

At the most aggregated level we may distinguish between commodities and intangibles. Within the production of the latter we are concerned with a type of service with contact between producer and consumer. The care services are characterised by direct participation by the consumer; the purpose of providing the services is to obtain an improvement in one or more conditions or states of the consuming person. The care services cannot be transferred to other consumers, and they are not storable. The production of personal services can be illustrated as in Figure 1.

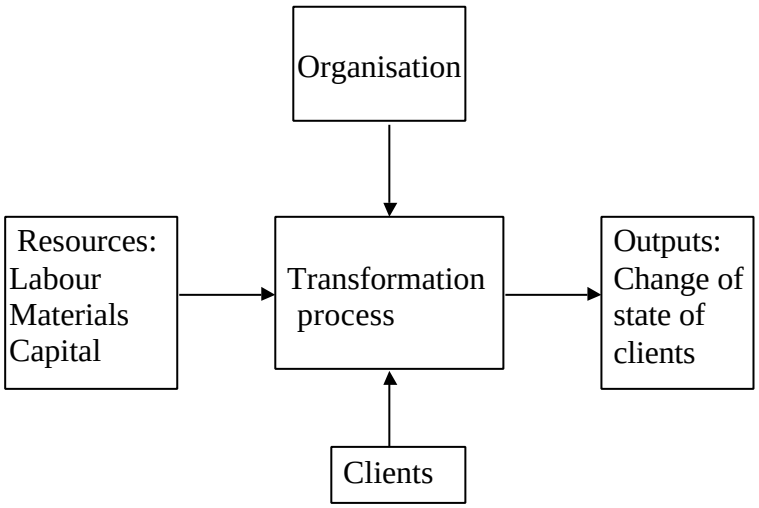

Figure 1. Service transformation process

The transformation of resources into outputs depends crucially on the interaction between the labour input and the client. The notion of an engineering blueprint for setting up a transformation process is not very relevant for this type of service production. Organisation is represented in a separate input box due to the importance attributed this factor in the service literature (see Lewin and Minton, 1986).

Quality

Quality is a key issue in service production. It is easy to imagine that two institutions providing care services for the same number of clients may do so with quite different use of resources depending on the quality of care. Quality is fairly straightforward to define for commodities: qualities are attributes characterising the unit of a commodity, e.g. a light bulb is characterised by the strength and evenness of light, the lifetime, etc. These attributes are (in principle) known at the time of the transaction. Good and bad quality may be distinguished in two ways: the declared technical standards are not met, or there are product variants with different technical standards. It is rather obvious that products with lower standards are cheaper to produce. Deviation from declared standards may be due to conscious cheating, and then the commodity is cheaper to produce, but may also be due to stochastic events, and is then not necessarily cheaper.

But for the attribute approach to function for personal services the former must be tied to a well-defined unit of service output. The most fundamental concept of a service output is that the output is a *stock* variable describing one or more *states* of the client. The states may be concerning physical health, psychological health, social functioning, etc. If we assume that the states are objectively measurable, then there is no need for separate quality variables. Quality is then contained in the measure of the states. We do not have the separability between a unit of a commodity, a light bulb, and one of its quality attributes, the lifetime. If we relate this line of thought to the basic notion of a utility function it is each person's evaluation of states that are subjective, but not the number of units of "state". Introducing x as a vector of current goods and S as a vector of states, we have the utility function:

$$U = U(x, S) \qquad (1)$$

The state variables may be influenced by external current inputs and/or "internal", i.e. either external effects from the consumer's enjoyment of current inputs (smoking) or taking vitamins every day for your long-run health, but not enjoying the pill itself. External inputs are inputs of various service producers, like hospitals, nursing homes, psychologists, etc. A general feature of the state variables is that it takes time to change their levels:

$$S(t) = s(\int_{t^o}^{t} ydt, \int_{t^o}^{t} xdt; b), \tag{2}$$

where t^o is a cut-off point for current inputs having impacts ($t^o < t$) , and y is the vector of external inputs. The parameter β is taking care of personal characteristics of the consumer; abilities, personality, etc. The resources used by a nursing home transforms into states of the clients, and better quality simply means that the states are at higher levels. We cannot separate out quality as an attribute.

Combining a utility function framework (1) and a "household production approach" (2) may be useful to understand the discussion of quality by practitioners or professionals in the care sector. The standard view is that quality is very difficult, perhaps impossible, to measure, and therefore the real quality is substituted by the *opinions* about quality as expressed by clients, relatives and professionals in interviews (see e.g. Gjerberg, 1995). But then the crucial distinction between subjective evaluation of a variable through a preference function and the objectively measurable variable itself is missed.

Proxies for quality

In real life we are far from having operationalised the state variable approach. There are no systematic efforts to establish objective measures of psychological and physical states of health, etc. At best the available data are showing resource consumption and the number of clients involved. It may then, even under the most favourable conditions, be very difficult to obtain data for states as defined above. Since the municipalities are spending the taxpayers' money on care, it is natural that the focus is on whether the amount of resources spent on a number of clients is really necessary. Having only access to observations of the inputs, y, and not the states, S, it is understandable that quality is introduced as a concept when

discussing the end results of spending the resources. One would expect, on the average, that better quality consume more resources also for services.

A more realistic strategy may be to aim for *proxies* for the states that are based on a combination of observable resource use and *standards* for the care services. By standards we mean a combination of resources yielding the *potential* for realising certain level of states for the clients ranging from physical conditions to psychological ones. In order to evaluate the possibilities of establishing standards it seems necessary to examine the transformation process portrayed in Figure 1 in detail. Institutionalised care involves support activities such as administration, preparing meals, cleaning, making up beds, maintenance of buildings and appliances, etc. where interaction with clients is not needed. The activities based on interaction with clients can broadly be divided into health related activities, involving medical personnel for consulting and "repairing" deficiencies, and pure care activities concerned with daily routines of personal hygiene, serving meals, social activities, time spent chatting or listening, other stimulation, etc.

In institutions standards may be based on the satisfaction of basic physiological needs, the maintenance of health, the conditions for exercising personal hygiene, sense of security, i.e. access to personnel and doctors, preservation of dignity and self respect, the degree of choice within the daily routine, i.e. the possibility for individual schedules, stimulation and social activities. In home care standards will depend crucially on amount of time spent with client, number of personnel dealing with the same client (the fewer the greater the possibility of building up trust and sense of security), observational skills of personnel as to early warnings of deterioration regarding physical and mental health, alarm systems and time it takes to do emergency calls, and accessibility of services during a 24 hours cycle. In addition some of the factors mentioned above for institutional care may be relevant. The standards may build on existing professional codes.

It may be in accordance with standard language to call the standards above for quality variables. Proxy quality indicators can also be related to skill levels and experience of staff.

3. **The method**

Production of care services typically involves several activities and quasi-quality attributes simultaneously. Furthermore, the nature of the process of transforming inputs into outputs is not well known or cannot easily be established referring to engineering blueprints. Establishing a most conservative standard of reference placing the frontier as close as possible to the data without imposing any functional form is accomplished by using the DEA approach, assuming piecewise linear production technology sets and "wrapping" the observations from above in output-input space therefore seems appropriate. But note that we assume unlimited substitutability between variables spanning a facet.

The technology set, T, can in general be written:

$$T = \{ (y, x) \mid y \text{ can be produced from } x \}, \quad (3)$$

where y is the vector of M outputs and x a vector of R inputs. It is assumed that the set is convex and exhibiting free disposability of outputs and inputs. Farrell (1957) technical efficiency measures can be defined with respect to this set, and they are identical to *distance functions* (introduced to economics in Shephard, 1953) or their inverse. The input-oriented technical efficiency measure, $E_{1,j}$ for unit j is:

$$E_{1,j} = E_{1,j}(y_j, x_j) = \text{Min}_q \{ q \mid (y_j, q\, x_j) \in T \}, \quad (4)$$

i.e. we seek the maximal uniform proportional contraction of all observed inputs allowed by the feasible technology set. The output-oriented efficiency measure, E_{2j} for unit j is:

$$E_{2,j} = E_{2,j}(y_j, x_j) = \text{Min}_j \left\{ j : \left(\frac{y_j}{j}, x_j \right) \in T \right\}, \quad (5)$$

i.e. we seek the maximal uniform proportional expansion of all observed inputs allowed by the feasible technology set.

Introducing a set of N observations the set, T, is estimated as a piecewise linear set by:

$$T=\left\{(y,x):\ \sum_{n\in N}\lambda_n y_{nm}\geq y_m\ (m\in M),\ x_r\geq\sum_{n\in N}\lambda_n x_{nr}\ (r\in R),\ \lambda_n\geq 0\ (n\in N)\right\},\qquad (6)$$

where λ_n is the weight for observation n when defining the reference point on the frontier, and N, M, R are also used as symbols for the index sets. It is assumed that the envelopment of the data is done as "tight" as possible, i.e. minimum extrapolation and inclusion of all observations are assumed. Furthermore, constant returns to scale (CRS) is specified. A special form of variable returns to scale (VRS) is obtained by restricting the sum of the weights to be 1:

$$\sum_{j=1}^{N}\lambda_j = 1 \qquad (7)$$

A piecewise linear production set with (7) included was first formulated in Afriat (1972) as the relevant set for efficiency analysis.

The estimator for the input-saving efficiency measure for observation j is then:

$$E_{1,j}=\underset{\lambda,q}{\text{Min}}\left\{q:\sum_{n\in N}\lambda_n y_{nm}\geq y_{jm}\ (\forall m\in M),\ q\,x_{jr}\geq\sum_{n\in N}\lambda_n x_{nr}\ (\forall r\in R),\ \sum_{n\in N}\lambda_n=1,\ \lambda_n\geq 0\ (\forall n\in N)\right\} \qquad (8)$$

This problem is a linear programming problem with N+1 unknowns and M+R (CRS) (+1 if VRS) constraints, and can be solved in a standard way[1]. Following Charnes et al. (1978) this is called the DEA model. The VRS case was reintroduced by Banker et al. (1984), without reference to Afriat (1972). A similar program can be set up for the output-oriented measure based on (4)[2].

The Farrell technical efficiency measures are radial, and measure the relative distance to the frontier from an observation. There are two natural directions: keeping output fixed and *input-orient* the measure, and keeping input fixed and *output-orient* the measure. The efficiency measures can be interpreted as total factor productivity measures in the standard meaning of an index of outputs on an index of inputs. The input–oriented (or input-saving)

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[1] We are using an in-house program of the Ragnar Frisch Centre**.**

measure is the ratio of the productivity of the observation and the corresponding reference point on the frontier, keeping outputs constant. The output-oriented (or output-increasing) measure is the ratio of the productivity of the observation and the corresponding reference point on the frontier, keeping inputs constant. Since the numerators (denominators) of the productivity indices in the input-oriented (output-oriented) case are identical, we do not have to worry about how the output (input) index is constructed. The efficiency score is based on proportional change of all magnitudes. Assuming that the input (output) index is homogenous of degree 1 in the inputs (outputs), the unknown input (output) index for the observation cancels out, and we are left with the efficiency score (see Førsund (1997) for further explorations).

For a VRS frontier technology the basic efficiency measures are extended to cover scale (see, Førsund and Hjalmarsson, 1974, 1979). A sort of a scale measure, termed gross scale measure in Førsund and Hjalmarsson (1979), but here renamed more

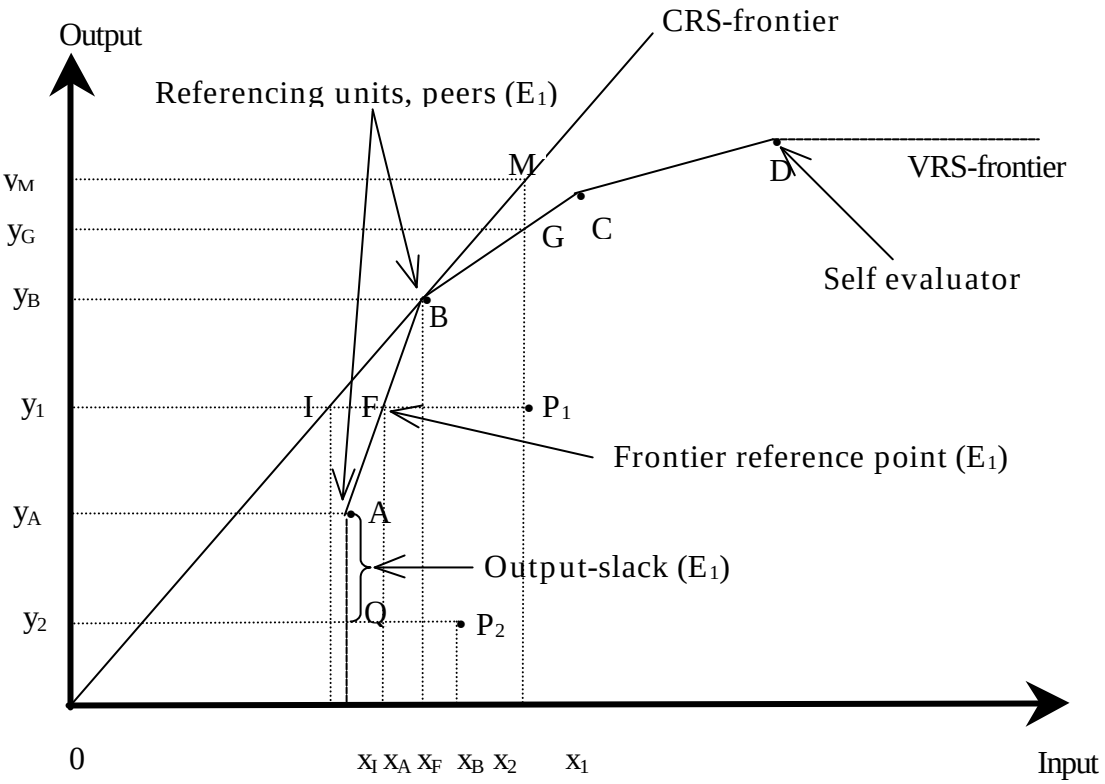

Figure 2. DEA frontier, concepts and efficiency measures

[2] In order to keep the linear programming format a maximisation problem is solved with $1/\varphi$ as variable.

appropriately *technical productivity measure*, is defined as the ratio of the productivity of the observation and the productivity at the corresponding (i.e. keeping observed output ratios and input ratios) technically optimal scale point on the frontier. We know (see Frisch (1965) or e.g. Førsund, 1997) that the latter productivity is maximal. The pure scale measures defined in Førsund and Hjalmarsson (1979), here simplified to *scale measures* may also be interpreted as productivity measures by forming ratios of productivities with the input- and output corrected reference points respectively on the frontier and optimal scale point. To realise that also in these cases we do not have to know the productivity indices is a little more involved, and require the introduction of the enclosure of the VRS production function by the smallest cone, i.e. a CRS technology. We will return to this explanation after the graphical presentation of the DEA frontier and the efficiency measures provided in Figure 2. Two inefficient units, P_1 and P_2 are shown, and the concepts used in the DEA analysis are introduced. The efficiency measures for observations P_1 are:

Input - saving efficiency: $E_1 = x_F / x_1$

Output - increasing efficiency: $E_2 = y_1 / y_G$

Technical productivity: $E_3 = (y_1/x_1)/(y_B/x_1) = E_1\,(CRS) = x_I/x_1 = E_2\,(CRS) = y_1/y_M$

Scale efficiency, input orientation: $E_4 = E_3 / E_1 = (y_1/x_F) / (y_B/x_B)$

Scale efficiency, output orientation $E_5 = E_3 / E_2 = (y_G/x_1) / (y_B/x_B)$

The way these measures are defined they are all between zero and one. The productivity- and scale measures can be expressed as ratios of productivity of the observation, P_1, and its two corresponding frontier points, F and G respectively, and the maximal productivity at the frontier at B. These measures can also be expressed as ratios of the slopes of the rays from the origin through these points and the slope of the ray to the point of maximal productivity, B. Returning to the productivity interpretation above for the E_3, E_4 and E_5 measures in general, note that the productivity measure is identical to the input- and output-oriented efficiency measures with the CRS support technology as the frontier reference technology, as stated above for Figure 2. But this is a general result because with more dimensions we require that observed output ratios and input ratios are kept fixed. Therefore, the last two

relations are also general. These can than be used to give E_4 and E_5 productivity interpretations.

The two main technologies, CRS and VRS are shown in the figure. We note the special feature of VRS in the DEA case: the technology does not include the origin. A non-increasing returns to scale technology (NIRS) could also be specified, in Figure 2 with OBCD as graph.

The terminology we will use is indicated in Figure 2. The efficient units when calculating the efficiency score for an inefficient unit are termed *referencing units*, or *peers* i.e. the efficient units with positive 8-weights in (8), and the point on the frontier is the *reference point*. Calculating, in the VRS case, E_1 for unit P_1, units A and B are referencing units (peers) and F is the reference point. Unit D is efficient, but is a *self-evaluator* calculating both input- and output- oriented measures.

We know slacks are an integral part of a LP problem. In Figure 2 we have an output-slack when calculating E_1 for unit P_2. With more dimensions we can also have input (output)-slacks when calculating input (output)-oriented efficiency, and we have a choice of presenting the radial efficiency measures, or non-radial ones including slacks (see e.g. Torgersen et al. (1996) for an overview).

Finally, the LP programme also calculates the dual and gives us all the shadow prices, which can be utilised to calculate marginal transformation rates and productivities.

The Farrell technical efficiency measure in the CRS case ($E_1 = E_2$) is the most used, but also the extended Farrell measures have been used in the literature under various names. However, the comprehensive scheme offered above, predating this literature, based on Førsund and Hjalmarsson (1974) and (1979) seems to have gone mainly unobserved[3].

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[3] For instance, Banker et al. (1984) call E_3 for "technical and scale efficiency", and E_4 for "(input) scale efficiency", while Färe and Lovell (1978), Färe et al. (1985), Färe et al. (1994)

4. Data and definitions of variables

The care services are of two general types; institutionalised care and home-based care. The home-based care is either nursing/medical or general assistance. The only available information is on number of clients receiving the three types of services, and their distributions on a few age groups. The level of care each client is receiving is based on two considerations: available resources of the municipality and level of need. The rate of number of clients to the number of potential "customers" varies across the municipalities. However, this is not sufficient to say that the level of services provided varies. Norway is a very egalitarian country. The available statistics do not tell us enough about the distribution of needs across the potential customers except for the variation in age group structure. The best we can do under the circumstances is to choose age groups as a proxy for different average needs, and to assume either that the main factor determining provision of services is a professional assessment of needs, or that the ratio of clients in need of services and the potential population is stable across municipalities.

Institutions also provide short-term services, such as rehabilitation or short -term stays to relieve families. This output is measured as the net number of clients exiting during a year (i.e. disregarding deaths). The only obtainable quasi quality variable is number of single-bed rooms.

The major input is labour, absorbing about 60% of the total current cost. Some classification on skill groups is available. However, the relationship between them is rather fixed, one

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do not recognise E_3 as a scale measure, but as a technical efficiency measure for CRS technology, probably due to $E_3 = E_1$ (CRS) = E_2 (CRS), and call E_4 input scale efficiency measure and E_5 output scale efficiency measure.

reason being a common labour union covering all municipalities. Sources for inefficiency may be found in support activities like administration, provision of food and cleaning. However, we cannot go to that detail, and we lump labour together. The other input is current expenditures (excluding wages), covering food supplies, cleaning, heating, transportation, etc. Data on capital inputs are not available.

The efficiency analysis is conducted on national statistics for nursing home services in each municipality in Norway for the year 1995 (Statistics Norway, 1996). According to the discussion above, production of nursing home services is divided into 13 variables of which 10 are outputs, one is a quality-proxy and two are inputs. The analysis is based on 471 municipalities. Table 1 shows the DEA-variables and descriptive statistics.

Table 1 DEA-variables, descriptive statistics 1995.

		Per municipality.			
Variable	Total	Average	Std.dev.	Min	Max
Outputs					
N*umber of receivers of:*					
home care nursing services 0-17 year	236	0.5	1.3	0	16
home care services 0-17 year	245	0.5	2.1	0	30
home care nursing services 18-79 year	33652	71	80	0	713
home care services 18-79 year	57591	122	156	2	1298
home care nursing services 80 year +	35577	76	90	2	652
home care services 80 year +	60137	128	162	3	980
Numbers of:					
nursing home residents 0-17 year	36	0.08	0.6	0	8
nursing home residents 18-79 year	11770	25	29	0	279
nursing home residents 80 year +	30938	66	74	1	748
net discharged nursing home residents	45893	97	138	0	1585
Quality					
Number of single-bed rooms	30987	66	79	3	804
Input					
Number of man-labour years	68563	146	163	7	1528
Operational costs (in NOK 1000)	4022334	8540	14266	174	159099

According to Table 1 there is large variations between the municipalities, e.g. the smallest municipality has just one nursing home resident in the age group 80 + while the largest municipality has 748 nursing home residents in the same age group. An average municipality has 66 nursing home residents who are 80 year and above.

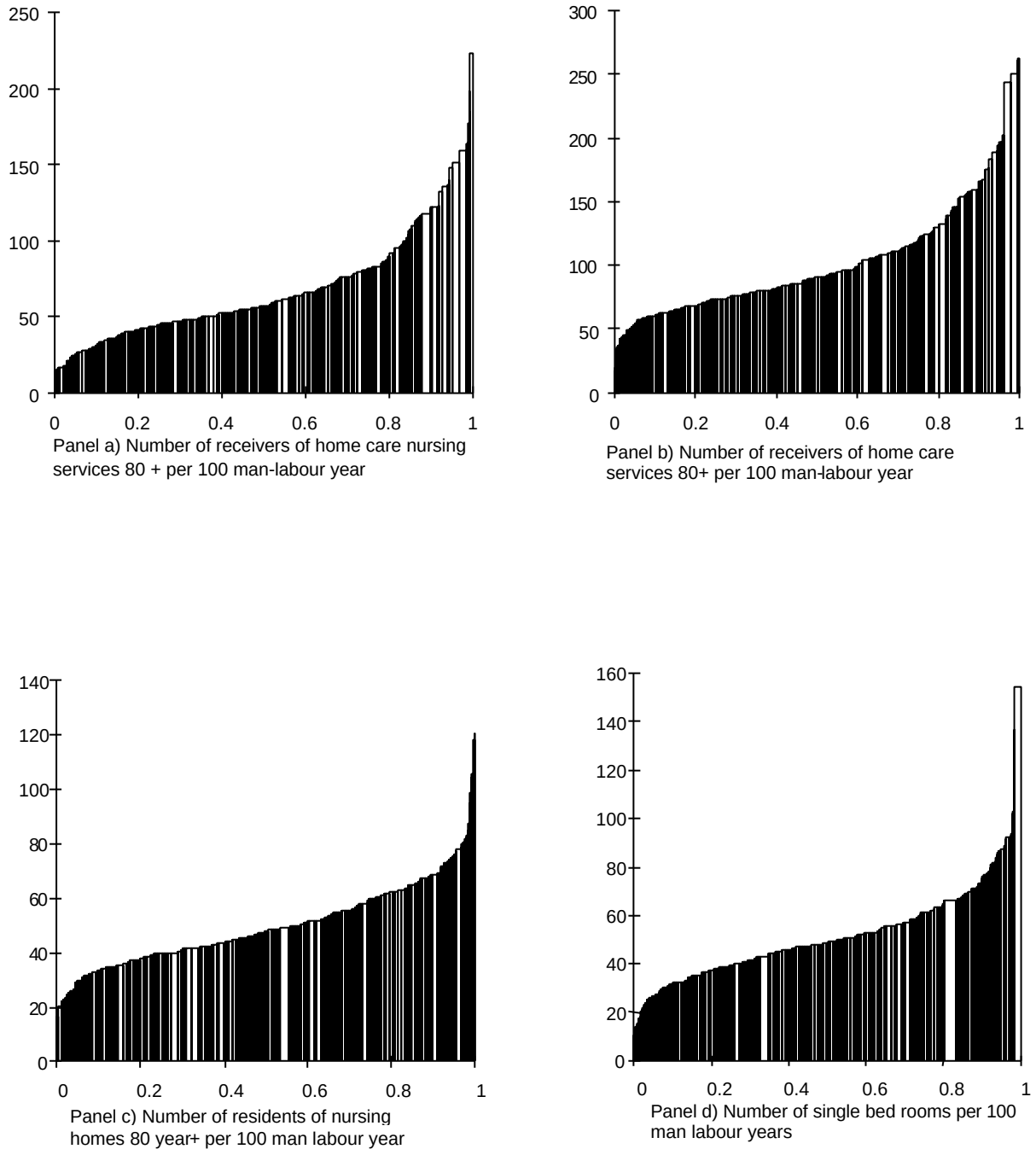

Figure 3 Salter-diagrams. Relative size measured as share of total output

One way of assessing the structure of the data is to calculate ratios between output- and input variables, and organise the results of these partial productivities in diagrams inspired by Salter (see Førsund and Hjalmarsson, 1987). Examples for four outputs and one input are shown in Figure 3.

Each histogram represents a municipality. The width of the histograms is the relative share of the output in question. The general impression is of a large variation in partial productivity between municipalities. As to location of units according to size, we see clearly in Panel a) that large municipalities have a higher number of clients receiving nursing in their homes in the age group 80+ than small municipalities per unit of labour input. This is also the case for receivers of home care, although not quite so pronounced. For institutions we do not see this size-dependent pattern, except for a tendency for small municipalities to be at the "worst practice" tail. For single –bed rooms it is interesting to see that there is also a group of small units at the "best practice" tail.[4] The diagrams can also be used to detect outliers as a start of a data checking process. We see examples in each panel, especially in Panels a) and d). The best practice observations will be especially important to check due to the frontier approach.

It is of vital importance for the credibility of the calculated DEA-scores that the quality of the output and input data is adequate, especially since it is our intention that the efficiency-scores shall give valuable information in the management of the production of nursing home services. Several leaders in the municipalities pointed out to us during the project that the data was of bad quality. This lead to a control of the data where we asked 23 municipalities whether the registered statistics was correct or not. The evaluation is documented in Erlandsen et al. (1997). The data control showed that there were very few faults in the registration of the data in the Statistics Norway. We should add that this check is not a test of whether the data measures what it is intended to measure, but to what extent there were faults in the registration of data reported from the municipalities.

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4 It would have been even more illuminating in the last case to study the number of single-bed rooms per client. This is done in Erlandsen et al. (1997), and shows larger municipalities to have relatively higher single-bed room ratio.

5. **Results**

Average tendencies

We have calculated all five measures defined in Section 3 and the average results are set out in Table 2. A VRS-technology is assumed, but as pointed out the measure E_3

Table 2. Radial efficiency scores.

Efficiency measures	Average	Standard deviation	Minimum
E1: Input saving	0.76	0.17	0.22
E2: Output increasing	0.78	0.16	0.26
E3: Technical productivity	0.70	0.16	0.22
E4: Scale (input-oriented)	0.93	0.10	0.55
E5: Scale (output-oriented)	0.90	0.11	0.55

may be interpreted as showing efficiencies according to a CRS-technology. The average levels for the two first measures E_1 and E_2 indicate roughly a potential for resource savings of 24 per cent, respective a production increase of (1/0.78 –1)100= 28 per cent, while the technical productivity measure E_3 indicates a somewhat larger
potential for productivity improvement if all units operate at optimal scale. The values for the two first measures are quite close, in fact the correlation over the sample is 0.99. The variation in efficiency is substantial for all three measures, as indicated by the two last columns (the maximal values for the efficiency measures are one). The (pure) scale efficiency measures E_4 and E_5 show less potential, average productivity may increase with 7.5% and 11% respectively, as is natural since technical inefficiency is removed by assumption. However, scale changes are not really relevant for policy purposes, since we are at the municipality level. But in general we can say that there is a tendency for large municipalities to exhibit diseconomies of scale, being too big, to a greater extent than small municipalities being too small.

The piecewise linear production technology opens for slacks in the solution of the LP model. It may therefore be relevant to consider the potential for input savings or output increase including the slacks. Following the procedure explained in Torgersen et al. (1996) (see also Figure 2) the average results are presented in Table 3. Including

Table 3. Slack-adjusted output-oriented efficiency scores. VRS technology.

Variable	Averages	Standard deviations	Min	Slack share
Home nursing				
Clients 0-17 years	0.39	0.46	0.00	0.78
Clients 18-79 years	0.63	0.24	0.11	0.55
Clients 80+ years	0.66	0.23	0.11	0.53
Home care				
Clients 0-17 years	0.67	0.45	0.00	0.70
Clients 18-79 years	0.70	0.20	0.14	0.34
Clients 80+ years	0.66	0.22	0.10	0.46
Institutions				
Clients 0-17 years	0.74	0.44	0.00	0.97
Clients 18-79 years	0.69	0.22	0.00	0.31
Clients 80+ years	0.73	0.19	0.02	0.27
Net discharges	0.60	0.32	0.00	0.61
Single rooms	0.72	0.21	0.08	0.22
Inputs				
Labour, man-years	0.76	0.17	0.22	0.02
Current expenditures	0.73	0.19	0.14	0.26

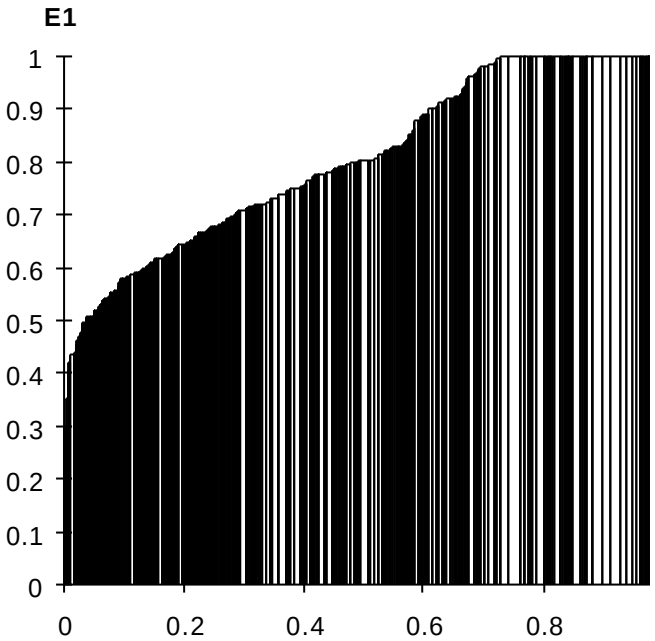
slacks will necessary show lower (or equal) efficiency scores. The measures are variable-specific, and the average results vary in the range of 0.60 – 0.76, with the exception of the value for the output variable home nursing for clients in the age group 0-17 years. This age group exhibits, in fact, a higher share of slacks in the formation of the efficiency scores for all three categories, and this is also the case for rehabilitation (net discharges). The extreme results of a slack share of 0.97 for the age group 0-17 years in institutions is due to the high number of units with zero observations for this variable. The slack share results could be utilised for aggregating output variables. The number of dimensions seem to be too high if one wants to come closer to a fully faceted frontier surface.

Efficiency distributions

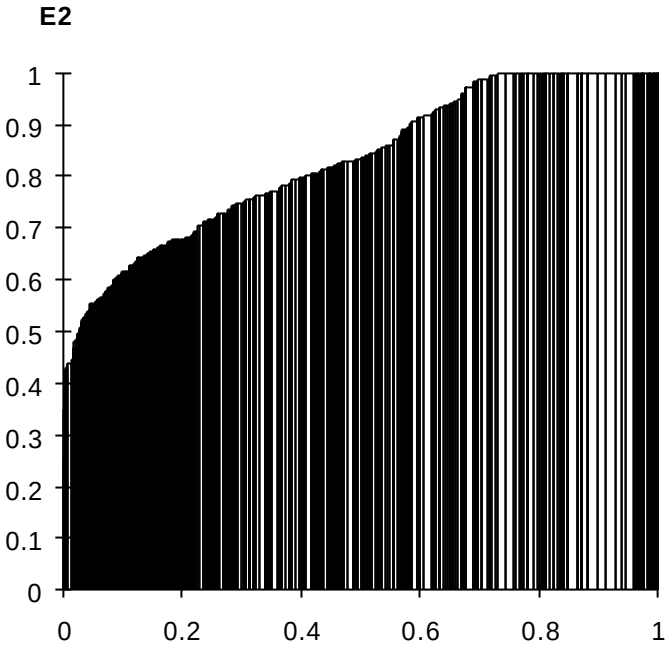
The distributions for the radial efficiency measures are set out in Figure 4, filling in the variation within the range of the extreme values in Table 2. Each histogram of the sorted distribution represents a municipality, and the width is proportional to a size variable. Inspecting Panels a) and b) we see a typical pattern of small units having lowest efficiency scores, and large units being efficient. This dichotomy is slightly more pronounced for the output-oriented measure. The efficient units represent about 30 per cent of the total number of clients in the age group 80+ serving as the measure of size, and the small units constitute the "worst performing" tail representing also about 30 per cent of these clients.

Panel c) shows that technical productivity (or the results for a CRS technology) has another type of distribution. The share of the efficient units has shrunk to about 10 per cent, and is still dominated by large units, but the rest of the distribution does not portray any systematic location of size groups.

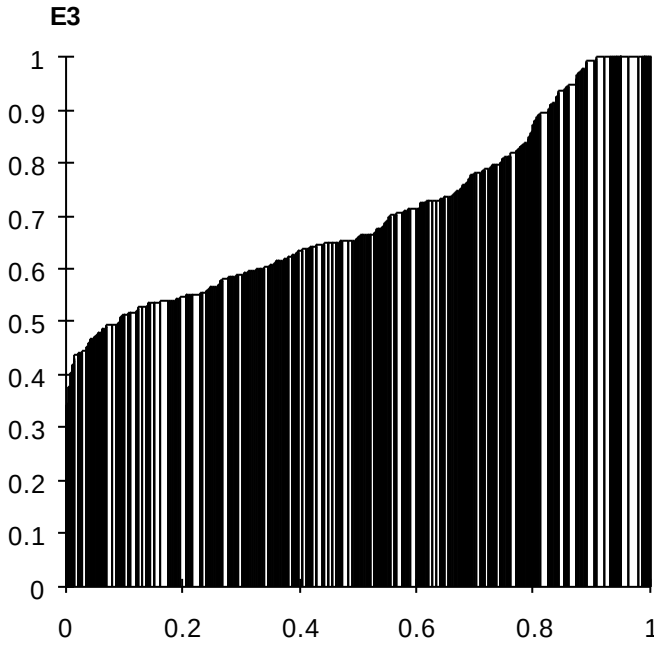
The scale efficiency measures set out in Panels d) and e) are quite similar, but different from the three others. The medium-sized units now constitute the "worst performance" part representing about 30 per cent of the clients, while the units close to being efficient are dominated by small municipalities. The efficient part is by definition the same as for the technical productivity measure, and is dominated by large units.



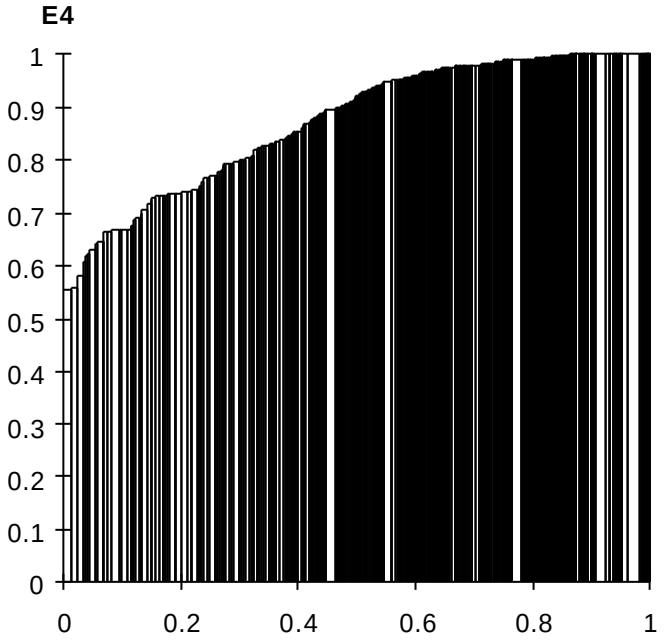
Panel a) Input-saving technical efficiency, VRS-technology



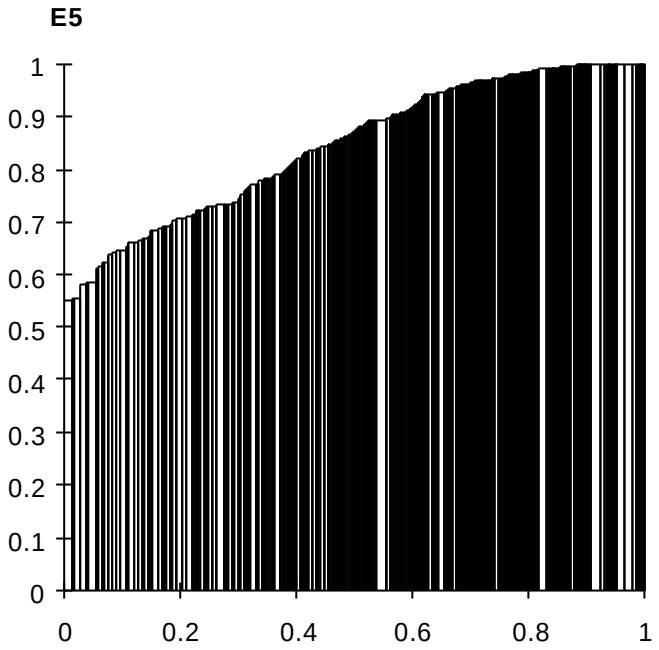
Panel b) Output-saving technical efficiency, VRS-technology



Panel c) Technical productivity



Panel d) Pure scale efficiency, input-saving



Panel e) Pure scale efficiency, output-saving

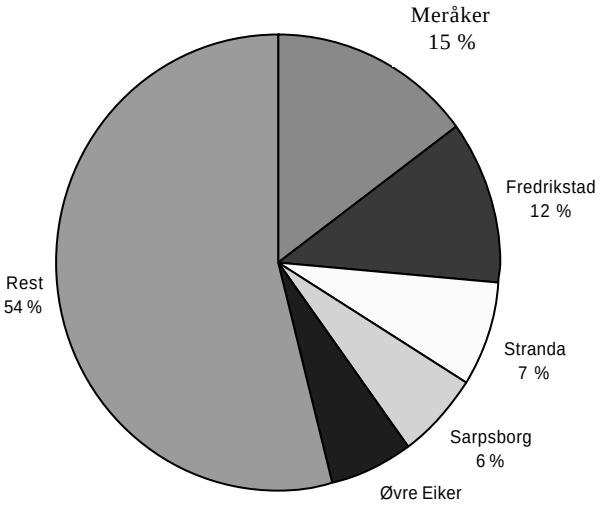
Figure 4. Efficiency-scores.

Relative size is measured by number of receivers of home care nursing services 80 year +

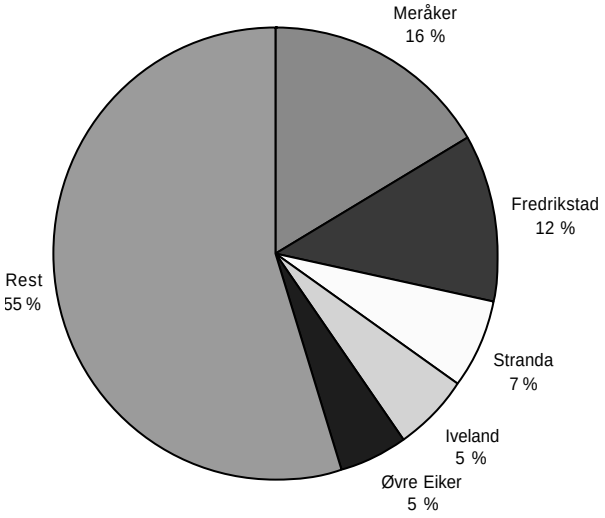
The peers

Corresponding to the relatively high number of outputs and inputs, compared to other studies, we have that 78 of the units are efficient when looking at the input-saving or output - increasing measure. As a way of showing the importance of these units as "role models" for the inefficient units we have calculated the *Peer index* defined in Torgersen et al. (1996) for the output-oriented measure E_2. It is illustrated by the pie diagrams in Figure 5 (based on slack-adjusted efficiency scores). The percentage number given outside the piece of pie is the relative increase in the specific output that may be realised if all the inefficient units having the peer in question as a reference unit would become efficient. The weights of the peers as reference units are used to calculated the index. Of the 78 units it turns out that there is a limited number that are the most important. Concentrating on the five most important peers

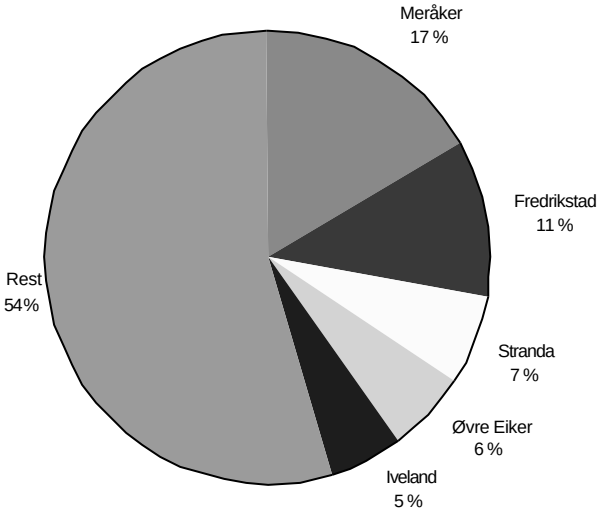
the least important peer has a peer index value of four or five, and the most important, that is the same for all outputs shown, a maximal index value of 20. The peers differ somewhat in index values according to type of output.



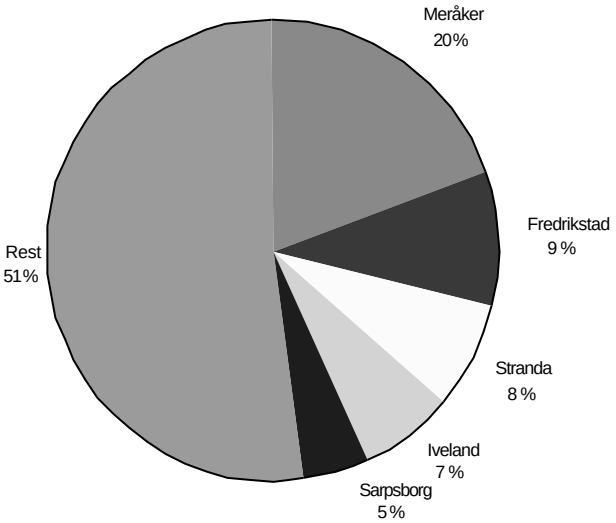
Panel a) Peer-index numbers.
Home care nursing services 80 year +



Panel b) Peer-index numbers.
Home care services 80 year +



Panel c) Peer-index numbers.
Nursing homes 80 year +



Panel d) Peer-index numbers.
Single-bed rooms

Figure 5. Peer index

Sensitivity analysis

The slack analysis indicated that our model might have too many dimensions. We will here report only on one formal test of the model specification concerning the quasi-quality variable single-bed rooms. There is a quite expensive plan in Norway for extending the coverage of single-bed rooms within a few years, while the opinion of the profession is that single-bed rooms is not so important for quality. It is therefore of special interest to test whether provision of single-bed rooms influence efficiency. The test design is to compare the efficiency scores for the output-oriented measure in the case of including and excluding the single-bed room variable. The null hypothesis is that the average efficiency scores are the same. Using a t-test (see Banker (1993) and Kittelsen, 1998) we cannot reject the null hypothesis. The average values are 0.775 without single-bed rooms and 0.778 with (the efficiency scores are increasing in the number of dimensions). Furthermore, a rank correlation between the efficiency scores gave a correlation of 0.98. Figure 6 shows the distribution of deviations. (The histograms have been extended below the 0.00 line to see the location of units according to size.) We have that for units representing about 60 per cent of the size variable (total number of clients), there is no perceptible difference in the scores.

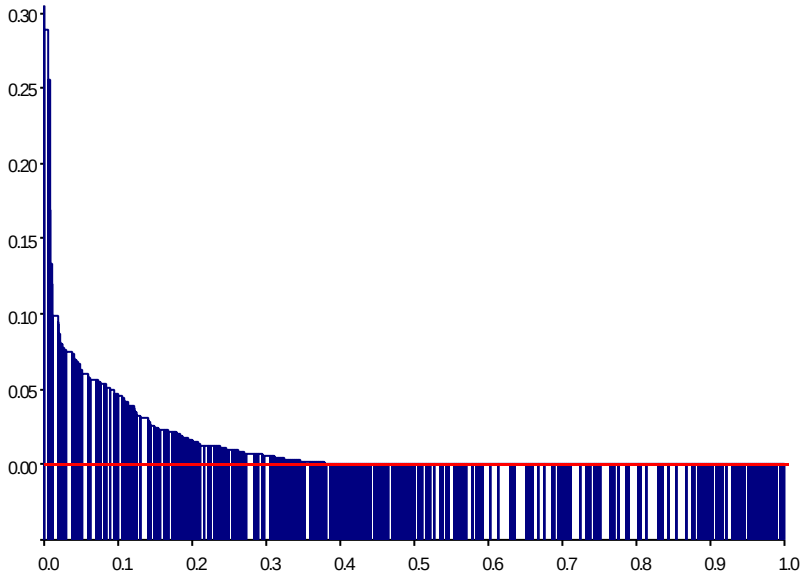


Figure 6. Test of single-bed rooms

There are substantial differences for a few units, but an average difference of only 0.04 in score values for the units with difference. We note that it is the medium-sized units that experience some differences, while the majority of large and small units have stable values. One explanation of the results is that the extra current resources used in providing single-bed rooms are insignificant for our input values, and that this output is not limiting when solving the programming problem (8) for the scalar-valued efficiency index.

6. **Concluding remarks**

The analysis has revealed quite a substantial difference in efficiency between municipalities in the provision of institutionalised and home based care. Peer municipalities have been identified, and inefficient municipalities could learn from studying closer the organisation and operation of the peers.

However, we have not been able to measure the ideal output variables, but been forced to work with counting of clients. The disaggregation into age groups may not be sufficient to capture differences in resource use due to providing different levels of quality. Counting the number of clients in home care may be especially vulnerable to variations in quality. But we have tested for whether the share of clients in home care has an effect on efficiency scores without finding any significant effect. Registration of time spent with clients would be an improvement. This should be possible to get data for within existing statistical systems at the primary level. But establishing data on the ideal states of clients is a longer-term project.

Studies concerned with the resource allocation process within municipalities may indicate variables that can explain differences in efficiency scores. We have experimented with a two-stage procedure correlating efficiency scores with existing interview data on client satisfaction, and organisational characteristics of the municipality, but without coming up with significant effects (see Erlandsen et al., 1997). Other variables that may be of interest are the

coverage of services in relation to demographic characteristics, and socio-economic variables such as income per inhabitant, etc.

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