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HEALTH CENTRE PRODUCTIVITY IN FINLAND:

Productivity change from 1980 to 1990 and productivity differences in 1990

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ABSTRACT: The productivity measured by a weighted sum of various visits and total running costs has decreased annually on average three per cent during 1980s in Finnish health centres. The decrease has been about two per cent per year in early 80s and almost four per cent per year in late 80s. The productivity differences between health centres have been analyzed by Data Envelopment Analysis (DEA) and it revealed considerable variation in productivity between health centres. There is some variation in average efficiency measures across provinces. Health centres with small population within their area tend to have lower efficiency scores than health centres with large population.

KEY WORDS: health centre, productivity, Data Envelopment Analysis

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TIIVISTELMÄ: Terveyskeskusten tuottavuus, mitattuna suoritteiden painotettulla summalla ja käyttömenoilla, on laskenut 1980-luvulla keskimäärin kolme prosenttia vuodessa. Tuottavuuden vuosittainen lasku oli noin kaksi prosenttia 1980-luvun alkupuolella ja noin neljä prosenttia 1980-luvun lopulla. Terveyskeskusten välisiä tuottavuuseroja analysoitiin Data Envelopment menetelmällä (DEA). Analyysin perusteella terveyskeskusten välillä on huomattavia tuottavuuseroja. Keskimääräisiä tuottavuuseroja oli myös jonkin verran läänien välillä ja asukasluvultaan erikokoisten terveyskeskusten välillä.

ASIASANAT: terveyskeskus, tuottavuus, Data Envelopment Analysis

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1. Introduction

In Finland health care expenditure has risen rapidly during recent decades. While in most other OECD-countries the rise in health expenditure was much slower in 1980s than in 1970s, in Finland health expenditure growth continued relatively constantly through 1980s. The annual average real expenditure growth per capita in OECD countries from 1970 to 1980 was 5.9 percent and from 1980 to 1990 2.7 percent. The respective figures for Finland were 4.5 and 4.1 percent (OECD 1991).

At least if measured by such indicators as the number of physician visits and hospital days, the utilization of health services has not grown at the same rate as the real expenditure on health care. From 1970 to 1988 the number of physician patient contacts in ambulatory care grew on average by 2 percent a year, while the average annual real growth of ambulatory care expenditure exceeded 7 percent. In hospital care the number of inpatient care admissions per capita rose on average by 1.3 percent a year and the number of beddays per capita decreased by 1.2 percent a year from 1970 to 1989. During the same period the real per capita growth of inpatient care expenditure was on average 3.7 percent a year (OECD 1991).

These figures indicate a potential productivity decrease, but there are other possible reasons for rapid expenditure growth compared to volume growth measured by output indicators based on patient visits and utilization of inpatient care. Some part of expenditure growth can no doubt be explained by rises in input prices of health care which have exceeded general inflation. Some part might be due to the fact that above referred output indicators do not cover entire output of health care provision. Some would argue, that these output indicators are misleading since they do not take into account changes in quality.

Anyway, the rise in health expenditure and present economic and fiscal problems in Finland require, that more attention has to be devoted to the resources that health care sector already

has. We need to ask among other things, can the volume or quality of services be increased by improving the productivity and efficiency of health care. For assessing the possibilities for productivity improvement, it is important to know how the productivity of health care has developed and whether there are large differences in productivity among producers of similar kind of health services.

The expenditure of health centres covered nearly one-third of total health expenditure in Finland in 1990 (OECD 1990). The aim of our study is to produce descriptive figures for development of productivity of health centres over the past ten years and to estimate the magnitude of productive differences among different health centres in 1990.

2. Earlier Finnish studies

There are a few earlier studies which have examined health care productivity in Finland. Most of these have assessed productivity change over time.

Hjerppe (1982) examined the development of productivity in Finnish health centres in 1973-80. According to his study there were no changes in labour productivity, but total productivity measured by the relation between visits and beddays and real running costs declined on average by 1.4 percent per year.

According to Saarelainen's (1987) study productivity of health centres fell on average by 2.2 percent per year in 1980-1985. For hospitals the decline of productivity was greater; the average annual fall in productivity was 4.7 percent.

Håkkinen and Luoma (1989) studied productivity development of Finnish health centres from 1975 to 1986 using more detailed output data than Hjerppe and Saarelainen whose aggregate output variable was based on the number of beddays and on the number of outpatient visits. Håkkinen and Luoma measured the output of health centres by a weighted sum of seven outpatient and

inpatient services. The alternative input measures were real running costs, real personnel costs and the number of personnel. According to their study total productivity declined on average by 3 percent and labour productivity by 2.8 percent a year. They also found differences in the development of productivity between provinces.

Alander et al. (1990) have studied the development of productivity of Finnish hospitals in 1981-86 and cross-sectional differences in hospital productivity in 1986. Total output of hospitals was defined as a weighted sum of inpatient days and outpatient visits by speciality. Total productivity fell on average by 4 percent annually and labour productivity correspondingly by 3.1 percent.

In a further study Pekurinen et al. (1991) measured output as a weighted sum of inpatient days and outpatient visits and as a weighted sum of the number of periods spent in hospitals and outpatient visits. Differences in hospital productivity were analyzed by various measures and methods of case-mix standardization: age-structure of patients, proportion of cases within main specialities, severity of cases treated, factor analysis and information theory. The age-structure of the patients proved to be a significant factor in explaining differences in hospital productivity but the proportion of patients treated in different specialities did not have a significant impact. Different methods to control case-mix produced broadly similar results. Even after controlling for case-mix large productivity differences between hospitals remained.

3. Productivity development from 1980 to 1990

As Evans (1981) has noted, general performance criteria applicable to the health care industry are in principle the same that one would apply to any other industry. Performance of health care system can be evaluated on criteria of allocative efficiency (are its products, at the margin, valued more than

the products of the next best resource use?), and on criteria of technical (productive) efficiency (are particular patterns of output produced with minimum resources?). The efficient working of health care system requires both.

Total productivity measures how much output is achieved by the use of all inputs. It can be defined by the ratio between the quantity of production and the weighted sum of all inputs. The other common way to express productivity is to relate output to the use of labor resources, ie. labor productivity. Since total productivity measures take into account all input usage they can be considered to reflect productive efficiency more adequately than measures of labor productivity.

In this study we concentrate on assessing productive performance of health centres. That is, we try to estimate how the total productive efficiency of health centres has changed over the ten year time period 1980-1990 without paying attention to changes in final outcome (effectiveness), for instance, health effects.

3.1. Methods

Stated simply productivity can be defined as the ratio between output produced and input usage. In measuring total productivity the volume or the value of total output is divided by a measure of total input usage. In measuring labour productivity output is divided by some measure of labour input.

Since health centres produce a number of different heterogeneous services there is no suitable single physical measure for total output of health centres. Different services have to be given appropriate weights before they can be added up to give a measure of aggregate output. Theoretically these weights should reflect marginal production costs of efficient producers. In the case of market goods the production value for an industry could be determined by using market prices as weights provided that markets could be considered competitive.

In competitive markets prices of commodities can be assumed to reflect marginal costs of production. For public health services, however, there are no useful market prices and so we have to look at other possibilities to assign weights for different services provided by health centres.

In the absence of market prices for valuing the output of public health services a common approach is to use average unit costs as weights (see e.g. Lindgren 1981). This is basically the approach we followed. However, due to the lack of reliable information of average unit costs for the whole country, we used unit costs of the health centre of Helsinki as weights. These unit costs are from the year 1990, the final year of our study period. Therefore our measure of change in aggregate output can be said to be based on the Paasche quantity index.

Because the average unit cost of inpatient day in relation to average unit cost of outpatient visit for the health centre of Helsinki (216 FIM, 574 FIM) differed from that of the average for the whole country (198 FIM, 604 FIM), we calculated output changes by adjusting the weight for the inpatient day. The Helsinki figure for inpatient day was altered so that the ratio between average outpatient visit and inpatient day would be the same as on average in the country (216 FIM, 659 FIM).

Our output measure is based on ten outpatient and inpatient services of health centres. We tried to cover as large proportion of services provided by health centres as possible. The number of laboratory tests and radiological examinations is not included in our measure of output. We considered these as intermediary output in producing final outputs. Outpatient services were measured by the number of visits and inpatient services by the number of beddays.

As an input measure we used total running costs of health centres. To eliminate changes in input prices and to express costs in 1990 prices, we have for years 1980-1985 used the health care price index developed by Häkkinen (1988). From 1985

onwards we continued Häkkinen's index by means of the price index of municipal health care provided by Statistics Finland.

3.2. Data

The data consists of information describing the activity of all health centres in Finland. Output data used in this study consists of number of different services provided by health centres measured by outpatient visits and inpatient days. For the years 1980-1983 and 1985-1988 data is derived from annual the reports of primary health care published by the National Board of Health. Due to the reform of planning and financing of social and health care in 1984, there are not corresponding data for the year 1984. For the years 1988-1990 the data source is the report information register (KETI) maintained by Ministry for Social Affairs and Health. Both of the above mentioned data sources are based on annual reports of health centres. These data are gathered each year in standard form from every municipality or federation of municipalities.

Over the years there have occurred some changes in the composition of data, that is gathered from health centres. This has caused some problems in compiling certain output series. For instance, some mental hospitals have been changed to health centres, which has increased the amount of "low price" beddays. In 1980-87 children's health care visits refer to visits by children of 1-6 years of age but in 1988-90 visits by children of 1-7 years of age. Because there were data on total occupational visits but not occupational health care visits in 1989-90, the amount of occupational health care visits in 1989-90 was estimated assuming that the relation between all occupational visits and occupational health care visits was in these years the same as in 1988.

For estimating productivity change we formed 10 output categories (appendix 1). These and their unit costs are taken from accounting data of the health centre of Helsinki. The output categories and their respective unit costs are:

Unit costs

	FIM
1. Health care visits (exl. health care visits included in categories 2-4 below)	175.63
2. Health care visits of children under 7 years of age	217.62
3. Health care visits of school children	91.35
4. Occupational health care visits	377.29
5. Medical care visits to physician	335.87
6. Medical care visits to other personnel	135.54
7. Visits of supervised domiciliary care	205.93
8. Dental care visits	296.50
9. Rehabilitation visits	189.69
10. Inpatient days (beddays)	658.91 *

* Adjusted figure (see section 2.1.)

Health care visits include both visits to physicians and to other personnel. Health care visits have been divided according to users: adults, small children and school children. This division is made because of different unit costs of visits between these groups. For the same reason medical care visits have been divided into visits to physicians and visits to other personnel.

Input data consists of running costs of health centres. These are derived from "Terveyskeskusten taloustilasto" (Economic statistics of health centres), an annual statistical publication compiled by central municipal associations.

3.3. Empirical results

If output mix and relative costs of different services change over time the estimate of change in aggregate output can be sensitive to the weights used. The output mix of outpatient care of Finnish health centres has, however, been remarkably stable over our study period, as is shown by table 1.

Table 1. The relative frequency of outpatient services in Finnish health centres during 1980-1990, percent

output categories*	1980	1981	1982	1983	1985	1986	1987	1988	1989	1990
1.	17	17	17	17	21	16	15	15	14	14
2.	5	5	5	5	5	5	5	5	5	5
3.	5	5	5	5	8	6	6	5	5	5
4.	1	1	1	1	1	1	1	2	1	1
5.	26	27	27	28	26	28	28	28	28	28
6.	13	12	12	12	11	13	14	14	15	15
7.	7	7	7	7	7	8	8	8	9	9
8.	17	17	17	17	14	16	16	16	16	16
9.	8	8	9	8	6	8	7	7	7	7

*See section 2.2.

Aggregate output of outpatient care, using unit costs of the final year as weights, grew on average by 1.2 percent annually from 1980 to 1990 (see table 2). Output of inpatient care (beddays) grew much more rapidly: the average annual growth of inpatient days was 4.9 percent. Applying Paasche quantity index to the whole of health centre production gives an estimate of 2.6 percent volume growth per year on average. During 1980-90 real running costs grew on average by 5.9 percent. Finally, referring to table 2, we note that both output and cost changes per year differed during the first half of 1980s and thereafter.

Table 2. Average annual percentage changes of health centre output and real running costs

	1980-1990	1980-1985	1985-1990
Outpatient output	1.2	3.4	-1.0
Beddays	4.9	6.5	3.4
Total output	2.6	4.5	0.7
Real running costs	5.9	6.9	4.8

Because the number of inpatient days has grown considerably more than the number of outpatient visits, we also made a calculation where we changed the ratio of cost weight of

inpatient day and the respective cost weight of outpatient visit to that prevailing in 1980. This gives an estimate of total output growth of health centres calculated by an approximate Laspeyres quantity index, because the output mix of outpatient visits did not change during the study period. This led to somewhat higher estimates of output growth than estimates based on Paasche quantity index (see table 3).

Table 3. Health centre production according to Paasche and approximate Laspeyres quantity indices during 1980-1990

year	1980	1981	1982	1983	1985	1986	1987	1988	1989	1990
Paasche index	1.00	1.04	1.11	1.15	1.24	1.26	1.29	1.30	1.30	1.29
Approx. Laspeyres index	1.00	1.04	1.13	1.16	1.26	1.30	1.34	1.35	1.35	1.34

Until 1987 health centre output grew substantially but after 1987 output growth seems to have stopped.

From 1980 to 1990 the average annual decrease of cost productivity of health centres, with output measured by Paasche quantity index and input measured by deflated running costs, was 3.1 percent. During late 80s cost productivity decreased much more rapidly than in early 80s. From 1980 to 1985 the average annual fall in productivity was 2.2 percent and from 1985 to 1990 4.0 percent. Output measure based on our approximate Laspeyres quantity index gives somewhat lower estimates for productivity decrease (see table 4.).

Table 4. The average annual change in productivity from 1980 to 1990, percent.

Output measure based on	1980-90	1980-85	1985-90
Paasche index	-3.1	-2.2	-4.0
Approx. Laspeyres index	-2.7	-1.9	-3.5

The Paasche and Laspeyres indices give estimates of the upper and lower bound of the "true" measure (see Lindgren 1981). Thus our estimates indicate that the average annual decrease in cost productivity of Finnish health centres was about 3 percent during 1980s, about 2 percent in early eighties and almost 4 percent in late 80s.

We also made some preliminary calculations about productivity development separately for outpatient and inpatient care. According to these calculations productivity fall was very rapid in outpatient care while in inpatient care no significant productivity change could be observed. We are not sure, however, whether these different productivity trends are real or whether they can at least partly be explained by the way joint resources or costs of health centres are apportioned into outpatient and inpatient care.

4. Differences in productive efficiency among health centres

In this section we shall study productivity differences of Finnish health centres in 1990. First, we shall discuss the method (DEA), then we describe the data and finally present results of our cross-section analysis.

4.1. Overview of the data envelopment analysis method

For assessing differences in productive efficiency among health centres we used data envelopment analysis - a method which has

come increasingly popular in recent years for analyzing efficiency of not-for-profit organizations.

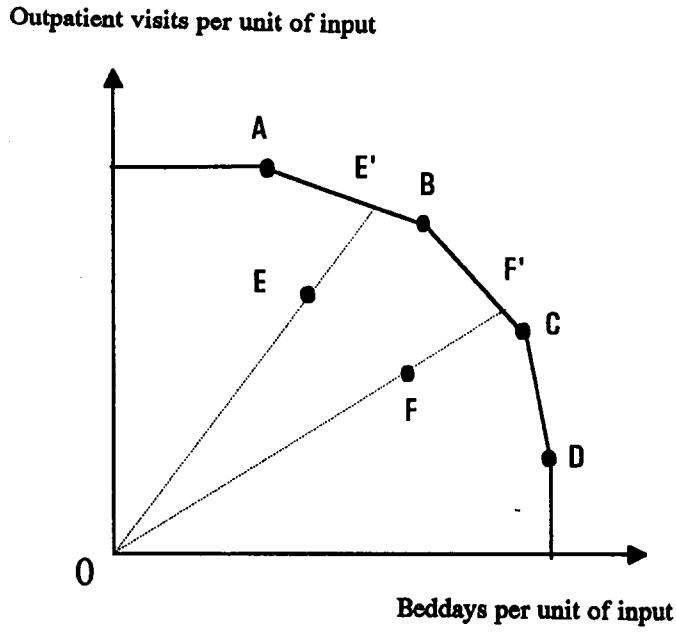
Data envelopment analysis (DEA) is a linear programming-based method that converts multiple input and output measures into a single summary measure of productive efficiency. DEA is based upon relative efficiency concepts proposed by Farrell (1957). Charnes et al. (1978) extended and developed Farrell's approach. They showed how Farrell's technical efficiency could be made computationally tractable by casting it in a fractional linear programming format.

DEA can be said to utilize an extended concept of Pareto efficiency. A production unit is not efficient if it is possible to augment any output without increasing any input and without decreasing any other output. This definition reflects an output orientation. Pareto efficiency can also be characterized with an input orientation as follows. An unit is not efficient if it is possible to decrease any input without augmenting any other input and without decreasing any output.

DEA provides an extremal predictor in the sense that the most efficient units within a group serve to define a piecewise linear production function and the remaining units are then evaluated relative to this efficient surface (Nunamaker 1985). Relatively efficient units obtain a measure of one, while relatively inefficient units obtain an efficiency measure of less than one.

To illustrate DEA one can consider the case where constant returns to scale (CRS) applies and where each unit of the same industry produces two different outputs, say outpatient visits and beddays, with a single input. Then each output is divided by the amount of input used to produce it, the units can be represented in a two-dimensional space as in Figure 1.

Figure1.



In figure 1 the points A-F represent the production units of the same industry. The efficient surface or the best practice frontier, as it is called by Grosskopf and Valdmanis (1987), is determined by enveloping the observed points using piecewise linear segments. This results in the locus of points depicting the units which produce most of either output per unit of input. In our case of figure 1 units A,B,C and D have this property that no other unit is superior on both dimensions, so they form (with extensions to the axes) the best practice frontier. The measure of productive efficiency of the unit is given by dividing actual output produced by hypothetical output it could produce if it were on the frontier holding output mix constant. For observation E the efficiency measure would be the ratio of distance OE to the distance OE'. Respectively for unit F the efficiency measure would be OF/OF'.

The illustration provided by figure 1 is, of course, simplified. In practical DEA applications there is usually a larger number of outputs and/or inputs. The example of figure 1 is based on the assumption of constant returns to scale technology. DEA provides also a possibility to measure productive efficiency with variable returns to scale

assumption. In this case one can use DEA to partition overall inefficiency into its scale and technical components (see Banker et al. 1984 or Färe et al. 1985).

Formally, calculations of productivity efficiency scores are made by solving the following fractional linear programming problem:

$$\max h_0 = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{ij}} \tag{1.1}$$

subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1; j = 1, ..., n \tag{1.2}$$

$$u_r \geq 0;\ r = 1, ...,\ s;\ and\ v_i \geq 0;\ i = 1, ..., m \tag{1.3}$$

The y_{rj} and x_{ij} represent amount of output r and amount of input i for the production unit j. Optimization is performed separately for each unit to compute an optimal set of weights (u_r, v_i) and efficiency measure h_0. The model chooses values of u_r and v_i which are most favourable to the unit that is being studied. As a consequence an unit that is superior to all others on any single output input ratio will be rated efficient.

As such the model (1.1) - (1.3.) is non-linear and can be difficult to solve numerically. Charnes, Cooper and Rhodes (1978) have, however, shown how this model can be converted into a model that can be solved by standard linear programming algorithm.

We have applied data envelopment analysis to analyze productive efficiency of Finnish health centres. Output was measured by aggregating services into seven output categories. We used ss a measure of input total running costs of health centres. This is a similar approach to that Pedersen et.al. (1987) applied to measure the efficiency of Danish hospitals. Because of our input measure we have not, strictly speaking, measured only productive efficiency. Our measure also reflects input mix efficiency of health centres, that is how well the mix of inputs is adjusted to their prices.

In our application of DEA we assumed constant returns to scale. Later on we intend to carry out analyses with variable returns to scale assumption, too.

4.2. Data

The data used in our DEA analysis is based on the report information register (KETI) in 1990. The data includes input and output information concerning 223 health centres. From the register we picked up 30 output variables, which were aggregated into seven output variables for the analysis (appendix 2).

The output categories for DEA analysis were:

1. Health care and medical care visits to physician
2. Health care visits to other personnel
3. Medical care visits to other personnel
4. Visits of supervised domiciliary care
5. Dental care visits
6. Special examinations
7. Inpatient days (beddays)

The input data consists of running costs without rehabilitation costs and costs of purchased services. These were excluded because respective outputs were not included in our output measures. The personnel costs were adjusted by cost of living bonus and by bonus for service of remote areas. This was done in order to eliminate main differences in input prices between health centres.

4.3. Empirical results

Using a data envelopment analysis algorithm, measures of productive efficiency were calculated for 223 health centres. For one of them, the cost data provided in KETI was apparently unreliable, and therefore the observation was excluded from the data set. At this stage we carried out efficiency calculations assuming constant returns to scale technology. Therefore, obtained efficiency measures can be interpreted in two ways. According to output oriented interpretation they show what the actual production is as a share of potential production for each health centre. Interpreting efficiency measures in input oriented way they show how much each health centre could reduce its input usage without reducing output if it were as productive as the best practice units. In our case where we estimated input usage by running costs, efficiency measures can also be interpreted to indicate cost saving potential of different health centres. Note that assuming CRS the efficiency measures based on output and input orientation are the same.

The results of our preliminary analysis imply considerable variation in productive efficiency of Finnish health centres, as the distribution of efficiency scores presented in table 4 shows.

Table 4. Distribution of efficiency scores.

Efficiency scores	Number of health centres
1.00	30
0.95-0.999	21
0.90-0.949	32
0.85-0.899	34
0.80-0.849	43
0.75-0.799	26
0.70-0.749	22
0.65-0.699	7
0.60-0.649	5
0.55-0.599	2
All	222

Thirty health centres got the value of one for their efficiency measure. The lowest efficiency score was 0.587. For 62, or 28 percent of health centres, the efficiency measure got the value below 0.8 implying that their output increasing potential was at least 25 percent or input saving potential at least 20 percent. Both the weighted (weighted by running costs of health centres) and unweighted average of efficiency measures was 0.86.

We made preliminary analysis of regional differences efficiency scores by comparing 11 provinces of Finland. Table 5 shows the average efficiency scores by province and gives some information on the distribution of these scores within provinces.

Table 5. Efficiency scores (ES) by province.

Province of	No.	Average	ES=1	ES<0.8	Min.
Uusimaa	21	0.830	1	6	0.687
Turku and Pori	36	0.874	6	4	0.659
Häme	22	0.903	3	3	0.703
Kymi	19	0.890	5	2	0.779
Mikkeli	12	0.811	1	6	0.611
Pohjois-Karjala	13	0.899	3	0	0.808
Kuopio	13	0.858	1	5	0.699
Keski-Suomi	10	0.839	1	5	0.717
Vaasa	31	0.887	8	8	0.686
Oulu	27	0.813	0	12	0.648
Lappi	18	0.771	1	11	0.587

There seems to be considerable variation in the average efficiency scores and in the relative frequency of low efficiency values between provinces. In Northern provinces of Oulu and Lappi efficiency scores below 0.8 are more common than on average. But, also in much more Southern provinces of Mikkeli and Keski-Suomi half of the health centres had an efficiency score below 0.8. One can also note that variation within provinces is far greater than variation in the average

efficiency between provinces. In all provinces, save Oulu (with the highest efficiency score of 0.971), there are some efficient health centres.

If provincial averages of efficiency scores are interpreted to indicate output increasing potential it would vary from 11 percent (Häme and Pohjois-Karjala) to 30 percent (Lappi). However, without further analysis, this kind of interpretation is perhaps not warranted. It is, for instance, possible that a part of the variation in efficiency scores can be explained by regional variation in input prices or input requirements which is not accounted for in our measure of input usage (running costs corrected with variation in personnel costs). It is also possible that treatment practices vary between different health centres. For instance, in sparsely populated Northern Finland the visit to the health centre may on average be more service intensive than in more densely populated areas.

As table 6 shows there seems to be an association between the size of population within health centre area and efficiency score. Health centres with small population tend to have lower efficiency scores than health centres with larger population. Especially, health centres which have more than 30 000 inhabitants in their area seem to be more efficient than the health centres with less than 10 000 inhabitants.

Table 6. Efficiency scores (ES) by population of the health centre

Population	Mean of ES	ES=1	ES<0.8 %	Number of health centres
< 5000	0.824	5	55	22
5000- 9999	0.835	7	34	59
10000-14999	0.864	3	22	51
15000-19999	0.858	4	28	25
20000-29999	0.866	3	21	29
30000-49999	0.901	5	19	21
50000>	0.890	3	13	15
Total	0.860	30	28	222

5. Discussion

Our results suggest a significant negative productivity trend for health centres in Finland. Especially, during late 1980s productivity seems to have fallen considerably. How robust are these estimates? There are several reasons why the estimates are necessarily not accurate.

First, although we have used a greater number of output categories than previous Finnish studies, our output measure is still relatively crude. Especially, measuring inpatient care solely in terms of inpatient days, is not wholly satisfactory, although health centre inpatient care typically is long term chronic care. A more appropriate solution could be the one adopted by Lindgren and Roos (1985) who divide hospital care into acute inpatient care measured by admissions and long term chronic care measured by beddays. This would not, however, give more favourable productivity development estimates, since the average length of stay in health centre hospitals has increased during 1980s (Salmela 1991).

Second, the statistics which have been gathered from health centre services have changed somewhat over the study period. Thus in order to get consistent time series it has been necessary to make some calculatory assumptions.

In our data the average annual growth of outpatient visits was 1.1 percent and according to Economic statistics of health centres the growth has been 2.0 percent. The difference between growth rates is explained by different coverage of outpatient visits. Our data does not include laboratory visits.

Third, it is possible that over the years there have occurred changes in the patient mix of health centres. This is not taken into account in our study. For instance, in the beginning of the 1980s the beddays of the elderly people have increased relatively more than beddays of younger age groups (Salmela 1991).

Fourth, we have not been able to include any measures of change in quality in our estimates of productivity.

Fifth, the validity of output measure based on the number of outpatient visits and bed days can be questioned. One could note, as Häkkinen (1988), that health services differ from other goods and services because treatment of a patient often requires several complementary services, which are produced in different health care sectors. Therefore a more suitable output measure than the one based on visits and beddays could be an output measure based on treatment episodes. This would, however, require data that are not provided by present health care statistics and registers.

The above mentioned reservations must be taken into account when our estimates of productivity change are interpreted. But it is unlikely, that these reservations could change the main conclusion, that productivity has notably declined in Finnish health centres during 1980s. The estimates of productivity change obtained in this study are of the same magnitude as those found for hospitals in early 1980s (Alander et al. 1990) and health centres for years 1975-1986 (Häkkinen and Luoma 1989, Luoma 1990).

In further research with more refined data our purpose is to find out reasons for the negative productivity trend of health centres. In this context we will also construct estimates for the development of labour productivity and investigate whether the development of productivity varies significantly across health centres. In further analyses we intend to apply the Malmqvist output index approach (for this approach see Färe et al. 1992).

The second part of our paper consists of an evaluation of productivity differences between health centres assessed by data envelopment analysis. This exercise revealed very considerable variation in productivity between health centres. If these productivity differences are real they imply major

productivity improvement potential. It is clear, however, that further study effort is needed to assess how robust our productivity difference estimates are. This is important since results obtained with DEA can be sensitive to measurement errors (Epstein and Henderson 1989). Some of the efficient units forming the best practice frontier may in fact be outliers. There is also a need to examine how robust the results are with regard to variable selection and definition. One should investigate, for instance, whether results change if instead of beddays the number of admissions is used as an output measure of inpatient care.

In further analyses possible reasons for productivity differences should also be examined. Associations between certain structural characteristics, e.g. size or personnel mix, of health centres and their productivity ought to be investigated. An interesting research question is also to what extent productivity differences can be explained by economic incentives, e.g. incentives caused by the state subsidy system.

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Appendix 1

The data for the study of productivity change from 1980 to 1990

The data on years 1980-86 is based on the statistics of the National Board of Health and years 1987-90 on the KETI-register.

1. Health care visits have been divided into four groups:
   - -health care visits of small children: in years 1980-87 children of 1-6 years of age, in 1988-90 children of 1-7 years of age.
   - -health care visits of school children
   - -occupational health care visits: For 1989-90 there are data on the total amount of occupational visits but not on the number of occupational health care visits. We estimated the number of occupational health care visits assuming that the relation between all occupational visits and occupational health care visits was in these years the same as in 1988.
   - -health care visits of other groups

2. Medical care visits to physician
   - -medical care visits to general practioners
   - -medical care visits to special physicians
   - -medical care visits to physicians of occupational health care
   - -medical care visits of school children and students
   - -medical home care visits of physicians

3. Medical care visits to other personnel
   - -all medical care visits to other personnel, inc. school children, students
   - -medical home care visits of other personnel

4. Visits of supervised domiciliary care
   - -all visits of supervised domiciliary care

5. Dental care visits
   - -systematic dental care visits
   - -other dental care visits

6. Rehabilitation visits
   - -all therapy visits

7. Inpatient days (beddays)
   - -the number of inpatient days

Appendix 2

The data for DEA-analysis

OUTPUT VARIABLES:

1. Physician visits
   - -medical care visits to physicians
   - -health care visits to physicians
   - -physician visits of school children
   - -physician visits of students
   - -physician visits of occupational health care
   - -physician home visits
   - -physician visits of family planning

2. Health care visits to other personnel
   - -health care visits to health nurse
   - -health care visits to other personnel
   - -all family planning visits minus family planning visits to physician

3. Medical care visits to other personnel
   - -medical care visits to other personnel
   - -medical care visits of school children
   - -medical care visits of students
   - -medical care visits of occupational health care
   - -medical care home visits minus home visits of physician

4. Supervised domiciliary care visits

5. Dental care visits
   - -systematic dental care visits
   - -other dental care visits

6. Beddays
   - -beddays
   - -0.5 x beddays in daycare hospitals

7. Special examinations and miscellaneous activities
   - -operations
   - -mammography screening
   - -special examinations of school health care
   - -transportations
   - -public health education events
   - -workplace inspections in occupational health care
   - -workplace visits by occupational health care personnel

INPUT VARIABLE:

As the measure of input we used adjusted running costs.
As the first step we calculated:

Running costs
minus running costs of purchased services
minus running costs of rehabilitation
plus running costs of purchase services of rehabilitation

As the second step we eliminated the effects of cost of living bonus and the bonus for service in remote areas on personnel costs by applying the following formula:

$$C_{ai} = 0.288C_i + 0.712(C_i/1.045(1+0.04R_i)),$$

where C_i refers to running costs of the health centre i and R_i to points on the basis of which the bonus for remote areas is calculated. One point implies that salaries (and other personnel costs which are determined on the basis of salaries) are raised by 4 percent. The figure 1.045 approximates the effect of cost of living bonus. The figures 0.288 and 0.712 are the average shares of non-pesonnel and personnel costs in health centres in 1989 derived from Economic statistics of health centres (for the year 1990 these figures are not available).