ORIGINAL ARTICLE

A three-year Performance Evaluation of the NHS Hospitals in Greece

Polyzos N

Department of Social Administration, Democritus University of Thrace, Komotini, Greece

Abstract

Purpose: The purpose of this study was to access the performance of 117 Greek National Health System (NHS) hospitals for the year 2011, to compare the findings with the results from similar studies of the previous years (2009 and 2010) and to investigate the changes during the last three years of financial crisis.

Method: An input-oriented Data Envelopment Analysis was used to measure three indicators, technical, pure technical and scale efficiency indicators. Data was collected from the reports of the web-based facility (ESY.net) which was developed by the General Secretary of Ministry of Health and Social Solidarity. The input variables were the number of physicians, the number of nurses and other personnel, the number of beds and expenditures of every hospital. The output variables were the number of inpatient and outpatient visits. Hospitals were categorized into three size groups.

Results: Between the years 2009-2011, all hospitals, especially middle-sized hospitals showed performance improvement on all three indicators. Specific problems were noticed mainly in large-sized hospitals. The technical efficiency of Large-sized hospitals was estimated at 80%, of Middle-sized hospitals at 82% and of Small hospitals-Health Care Centres at 89%. Pure technical and scale efficiency varied between satisfactory levels throughout the study period.

Conclusion: Comparing the 2009-2011 data, an improvement of technical efficiency in NHS hospitals has been achieved up to 100%, mainly in the middle-sized hospitals. Specifically, an increase of best practice hospitals has been noted, especially in the middle and small-sized hospitals, when certain units were added the technical efficiency reached over 80%. The consequences of the spending-cuts and the constant reforms appear to have a positive effect on hospitals' efficiency. Hippokratia 2012, 16, 4: 350-355

Key-words: NHS Hospitals, Efficiency, Data Envelopment Analysis, Technical Efficiency, Pure Technical Efficiency, Scale Efficiency, Health Care Region.

Coresponding Author: Nikos Polyzos, Associate Professor of Health Service Management, Former Secretary General of Ministry of Health (11/2009-4/2012), Department of Social Administration, Democritus University, Alexandroupolis, Greece

Introduction

Since the beginning of 2011, in the relevant web application of the Ministry of Health and Social Solidarity (named ESY.net), authorized personnel of NHS Hospitals and Health Care Centres is required each month to upload the necessary operational and financial data, data that is verified by its overseeing Health Care Region (HCR) administration.

This data mechanism was established by the General Secretary, and his colleagues, for the sole purpose to continuously monitor Hospitals, Health Centres, their administration and the seven HCRs. With the continuous operation of the web-based facility ESY.net, the Ministry of Health and Social Solidarity (MoHSS) is able to monitor data on revenue receipts, payments, arrears, medical expenses, staff payroll, Diagnostic Related Groups (DRGs called KEN in Greek), number of admissions, outpatients, surgeries, medical examinations and other relevant information.

Considering that these figures have improved significantly compared to previous data and are probably more reliable due to persistent and continuous control, we conducted a study that measures and evaluates the performance of NHS Hospitals by the method of Data Envelopment Analysis (DEA). Then, we made a comparison with the corresponding results from two methodologically equivalent studies conducted in 2009 and 2010, which have been published in previous Annual Reports of the General Secretary of the MoHSS.

The objectives of this study is to document and evaluate the performance of NHS Hospitals, for another year, to identify appropriate ways of exploiting their productive potential and to further improve the resources available of healthcare units under consideration.

Data Envelopment Analysis Methodology

Data Envelopment Analysis is a linear programming procedure for a frontier analysis of inputs and outputs, with the main objective being the separation of the "efficient decision making units" (such as hospitals) from the less efficient ones by establishing a "frontier" of efficiency.

The basic DEA model introduced by Farell[1] in 1957, but the first application of this method dates back to the 1980's when it was developed by Charnes et al (CCR model)[2] and then extended to incorporate variable returns to scale by Banker et al[3]. It is an extremely popular and

widespread tool, used in diverse fields for efficiency estimation, including the health care domain[4-6]. Moreover, an extensive bibliography has accumulated over the years[7,8].

This method has several strengths as it is able to manage complex production environments with multiple input and output technologies and comparisons are directly against peers, but some noteworthy weaknesses as well, with the foremost that results are prone to measurement errors and are highly sensitive to outlier observations[9,10]. Furthermore, the ability of DEA is often limited by the small number of units in study samples, and it has been suggested that $N \geq 3 * (m+s)$, where N is the number of units, m the number of inputs and s the number of outputs[11].

DEA studies - in Greece - conducted over the past years have commonly demonstrated the potential for significant efficiency improvements not only in NHS hospitals[12-18] but also in primary care facilities[19,20].

Sample Collection

The sample consisted of 117 out of 131 NHS hospitals. Fourteen specialty hospitals (nine psychiatric, two maternity, one dermatological, one ophthalmological and one cardiological hospital) were excluded from the analysis to increase sample homogeneity. The 117 hospitals were classified into three categories to reflect the size, the similarity, the intensity use of resources and the range of services they provide. These categories were[21,22]:

- Large Hospitals or Tertiary Care Hospitals, with more than 400 beds (N=29).
- Middle-sized Hospitals or Secondary Care Hospitals, with less than 400 beds (N=71).
- General Hospitals – Health Care Centres, with less than 100 beds (N=17).

The present study was based on data reported at MoH webpage coming from operational and financial reports entered in ESY.net at the end of 2011[23]. For the purpose of evaluation, the input-oriented DEA model was used, because input quantities are the primary decision variables over which managers have most control.

Indeed, during the last two years, healthcare policymakers and hospitals administrators in Greece are under constant pressure to reduce expenditures. This and other measures are explicit requirements stated in the MoU between the Greek Government and the European Commission, the International Monetary Fund and the European Central Bank (known as the "Troika") in order to secure a series of bailout funds.

Furthermore, they were selected four input and two output variables based on the experts opinion, the experience from our previous studies and our economic theory[24]. They were chosen as the basic variables because they can identify in the best possible way, the labour, the capital, the array of services and the general results of hospitals' productivity. Thus, as inputs were chosen the number of physicians, the total number of nursing staff and other personnel, the number of beds and the total operational expenditures. The latter concerned four categories (pharmaceuticals, sanitary materials, orthopaedic materials and chemical reagents), which represent approximately the 80% of the operational hospital expenditures, as well as expenses for consumables and other services. As outputs, the number of inpatient and outpatient visits were utilized (Table 1).

For each of the hospital size categories, three main indicators were estimated, namely overall technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE), under the assumptions of constant and variable returns to scale via Warwick DEA Software (Deawin.exe)[25].

In other words, the overall technical efficiency measures if and to what extent a hospital produces the maximum possible output based on the inputs and if it consists of a combination of two other factors such as the pure technical efficiency which reflects the administrative capacity and the efficiency scale which refers to the optimum size of hospitals cost.

Results

• Best Practice Units - Comparative data 2011 to 2009 – 2010

The efficient frontier consists of the best practice units. Those units present 100% efficiency in terms of technical efficiency. Pure technical efficiency and scale efficiency are used as a target for the less efficient decision making units, which should properly modify the ratio of inputs and outputs in order to achieve performance comparable to the best practice units.

For the year 2011, 24 NHS hospitals utilized their available resources in the best possible way, presenting first-rate indicators on the operation of productive factors and productivity in accordance with their size. Out of the 24 Hospitals, 6 were Large hospitals, 12 Middle-sized and the remaining 6 hospitals were General Hospitals – Health Care Centres (GH-HC).

Hospitals which achieved performance improvement are the Cancer Hospital in Salonica and the General Hospital of Heraklion. They were able to be placed among the best practice units for the year 2011. It is worth mentioning the performance improvement of the Cancer Hospital of Kifisia (+42%), and some other Middle-sized hospitals, such as Agios Demetrios, Grevena, Larisa, Karditsa and Pyrgos.

Specifically, the technical efficiency values of these hospitals were extremely low in 2009 (55%, 61%, 62%, 67% and 68% respectively), while in 2010 were improved significantly (78%, 98%, 92%, 99% and 91% respectively) and managed to present better indicators in 2011, based on the size of their infrastructure and the utilization of production factors (Table 2.1).

This study is referred to 26 hospitals for the year 2010, and shows 100% efficiency improvement for all three indicators mentioned above. Out of 26 hospitals, 7 hospitals were tertiary care hospitals, 13 secondary care hospitals and 6 small capacity hospitals – Health Care Centres. Similarly, for the year 2009, 21 NHS hospitals (8 Large hospitals, 8 Middle-sized hospitals and 5 GH-HC) reached efficiency improvement for the three indica-

Table 1: Profile of hospitals' per health care region and size category.

HCR	Category of Hospital	N	Inputs				Outputs	
			Physicians	Other Staff	Beds	Expenditure	Admissions	Outpatients
1st	Large	12	426	1.011	556	52.605.832	40.725	133.203
	Middle	9	125	334	162	9.029.939	11.633	50.899
	Small							
2nd	Large	5	407	924	486	40.956.319	33.856	140.235
	Middle	7	139	405	197	12.773.623	12.133	76.378
	Small	6	33	105	53	2.080.918	2.198	23.937
3rd	Large	2	474	1.085	712	60.612.539	62.107	233.190
	Middle	12	104	311	165	7.511.922	11.008	88.035
	Small							
4rth	Large	4	448	1.003	599	52.488.889	48.114	201.327
	Middle	9	147	489	244	12.013.895	17.401	120.595
	Small	1	31	106	40	1.234.534	2.181	36.876
5th	Large	1	433	1.227	576	61.691.116	63.145	184.136
	Middle	10	125	431	194	11.302.625	16.456	95.936
	Small	2	23	70	28	937.919	1.137	29.624
6th	Large	2	542	1.471	768	70.005.050	63.265	208.190
	Middle	22	92	335	151	8.479.890	10.480	73.868
	Small	5	38	113	58	2.315.779	2.828	39.628
7th	Large	3	387	998	560	46.346.614	40.248	208.619
	Middle	2	118	331	163	8.629.250	9.638	79.575
	Small	3	42	125	56	1.643.376	2.624	44.921
Total	Large	*29*	*445*	*1.103*	*608*	*54.958.051*	*50.209*	*186.986*
	Middle	*71*	*121*	*377*	*182*	*9.963.021*	*12.678*	*83.612*
	Small	*17*	*24*	*74*	*34*	*1.173.218*	*1.567*	*24.998*

* Expenditure figures correspond to 2011 annual hospital expenses (€).
** Outpatients includes scheduled and emergency visit to outpatient departments.

tors (Figure 1).

Moreover, for the same study period (2009-2011), 11 hospitals (3 Tertiary, 4 Secondary and 4 GH-HC), have reached the maximum TE, PTE and SE which means the best performance based on utilization of recourses and production scale. Among these hospitals were included the Childrens' Hospitals of Athens and Patras, probably because they were operated with lower costs than the adult hospitals, such as a Large Hospital of Salonika (3rd HCR), two Middled-sized Hospitals (6th HCR) and four General Hospitals - Health Care Centres (one from 2nd HCR, one from 4rth HCR and two from 6th HCR).

• **Technical efficiency**

For the year 2011, the technical efficiency for the remaining hospitals (excluding the benchmark units) is ranged from 26% to 99%. In fact, comparing the results of 2010 study, seven secondary care hospitals managed to achieve a much better indicator of technical efficiency up to 90% or higher, reaching almost the performance of the best practice units. Those hospitals can be considered among the model hospitals, and follow the same or an even more productive clinical and administrative work.

Specifically, the mean of the technical efficiency for large hospitals was estimated at 80%, for middle hospitals at 82% and for GH-HC at 89%. These results are similar to the findings of the 2010 study. The respective figures were lower in 2009 with an estimated technical efficiency at 83% for the tertiary care hospitals, 64% for the secondary care hospitals and 86% for GH-HC (Figure 2).

Out of the 29 hospitals, 23 large hospitals presented lower technical efficiency. Most of these hospitals reached moderate to very high technical efficiency and only seven hospitals presented quite low technical efficiency below 70%. Basically, the biggest problem occurred in two hospitals of the 1st HCR (51% and 56% technical efficiency respectively) because they treat difficult and severe cases, due to their nature and specialty, and have higher than the average (6 days) duration of hospitalization. This analysis compares these hospitals with other similar size hospitals of this category.

However, it is imperative for the administration of the hospital and its staff to make greater efforts to improve the efficiency of the hospitals, even though the severity of the cases could explain to some extent these results.

For the medium-sized hospitals, the majority of the hospitals showed moderate to very high performance. Only 17% of medium-sized hospitals in the sample have reached low to very low technical efficiency (i.e. less than 70%). However, two hospitals presented again extremely low technical efficiency (26% and 49%) which shows a further reduction of this indicator during the year 2011, a decrease of approximately 7% - 10% between 2010 to 2011.

The hospitals of the last category (GH-HC) have achieved the highest performance improvement. Specifically, 16 out of 17 small hospitals reached technical efficiency scores over 70%. Certainly, the small capacity hospitals are considered precisely productive because of their extremely small size (50 beds on average) and the superior performance of their outpatient departments. Therefore, it is important to reinforce the activities of the Primary Health Care (PHC), the rehabilitation Centres of chronically ill patients, and other relevant units.

Furthermore, the test results from the repeated analysis showed that the measures for the dependent variable TE,

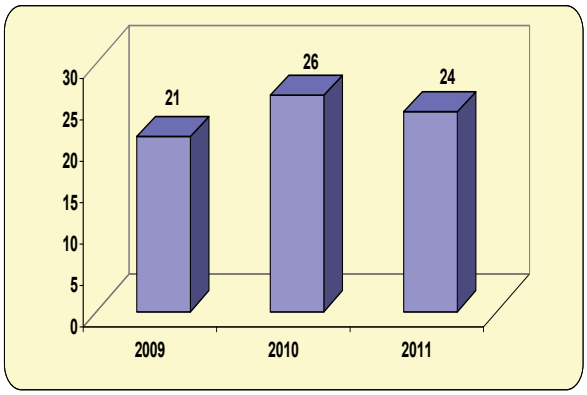

Figure 1: Best Practice Units (2009 - 2011).

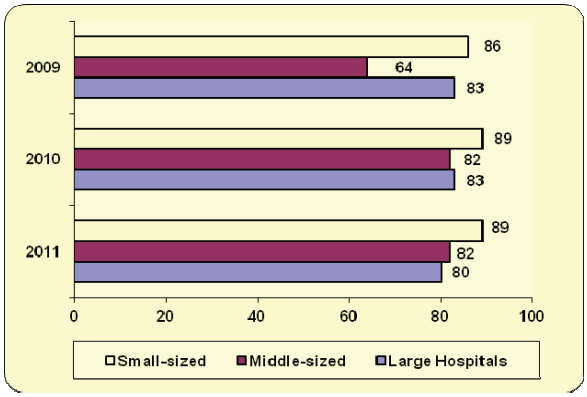

Figure 2: Technical efficiency by hospital category and year.

Table 2.1: Mean (±SD) TE, PTE, SE values by hospital category and year.

1. Large 2. Middle 3. Small	TE 2009	PTE 2009	SE 2009	TE 2010	PTE 2010	SE 2010	TE 2011	PTE 2011	SE 2011
1. Mean	82.69	89.24	92.52	83.31	90.31	92.45	80.10	88.41	90.69
N	29	29	29	29	29	29	29	29	29
SD	17.142	13.021	12.203	14.948	12.793	10.200	14.903	13.263	10.121
Minimum	39	57	39	52	53	54	51	55	72
Maximum	100	100	100	100	100	100	100	100	100
2. Mean	64.31	71.68	90.24	81.69	86.17	94.77	82.14	87.79	93.77
N	71	71	71	71	71	71	71	71	71
SD	20.293	21.079	11.655	15.612	13.620	8.872	15.175	12.894	11.083
Minimum	19	19	48	36	54	36	26	49	26
Maximum	100	100	100	100	100	100	100	100	100
3. Mean	85.94	91.41	94.24	88.65	94.53	93.71	89.24	93.71	95.35
N	17	17	17	17	17	17	17	17	17
SD	15.192	14.569	8.311	13.624	9.754	9.816	12.086	10.190	8.314
Minimum	51	52	66	66	68	68	69	73	69
Maximum	100	100	100	100	100	100	100	100	100
***Total* Mean**	72.01	78.90	91.38	83.10	88.41	94.04	82.07	88.80	93.24
N	117	117	117	117	117	117	117	117	117
SD	21.083	20.493	11.391	15.243	13.192	9.321	14.861	12.700	10.528
Minimum	19	19	39	36	53	36	26	49	26
Maximum	100	100	100	100	100	100	100	100	100

SD: Standard Deviation, TE: overall technical efficiency, PTE: pure technical efficiency, SE: scale efficiency.

the hospital size (group) and time are statistically significant (F=5.906, p=0.004 and F=32.822, p<0.001) (Table 2.2).

• Pure technical and scale efficiency

For 2011, pure technical efficiency of large and middle-sized hospitals was estimated at 88% and at 94% of GH-HC. Similarly, for 2010 this indicator was estimated at 90% for large hospitals, 86% for middle hospitals and 95% for smaller capacity hospitals, whereas for 2009 it was estimated at 89%, 72% and 91% for the three categories respectively. Without a doubt, fairly high and improved efficiency scores were noted compared to the first NHS hospitals efficiency study.

Finally, the scale efficiency of large hospitals was estimated at 91%, at 94% for the middle-sized hospitals and at 95% for the GH-CH. The corresponding results for the three categories of hospitals were 92%, 95% and 94% for 2010 and 93%, 90% and 94% for 2009.

According to the above mentioned indicator, most NHS hospitals were characterized by a relatively high scale efficiency, which implies that the majority of units had a proper to ideal size in relation to their produced outcome. Hence, all tertiary care hospitals had a good to exemplary scale efficiency (from 72% to 100%), while only two secondary care hospitals were inefficient in terms of size and infrastructure (26% and 53% SE). On the other hand, they utilised in the best possible way their outputs and only one out of 17 General hospitals-health centres was estimated to have somewhat low scale efficiency (69%).

Overall, significant changes were noted in efficiency scores between the years 2009-2011 (p<0.001 for PTE indicators and p=0.02 for SE) (Table 2.2). More specifi-

Table 2.2: Test results from repeated measures analysis.

TE			
R^2 =.712	Adjusted R Squared=.566	F=5.906, p=0.004 (size), F=32.822, p<0.001 (year)	Sig.=.004
PTE			
R^2 =.758	Adjusted R Squared=.635	F=7.027, p=0.001 (size), F=37.197, p<0.001 (year)	Sig.=.001
SE			
R^2 =.661	Adjusted R Squared=.489	F=0.482, p=0.619 (size), F=3.878, p=0.02 (year)	Sig.=.619

Table 3: Technical efficiency by hospital category and health care region (%).

TE Efficiency Scores 2011 - 2009 (%)									
Health Care Region	2011			2010			2009		
	Large	Middle	Small	Large	Middle	Small	Large	Middle	Small
1st	74	71		80	66		80	57	
2nd	77	73	80	76	70	86	75	43	82
3rd	93	90		100	87		84	74	
4rth	83	86	100	82	88	80	86	70	93
5th	92	88	90	100	83	90	100	64	98
6th	90	81	95	95	86	93	85	67	90
7th	89	73	94	87	76	89	94	54	97
Total	85	80	92	89	79	88	86	61	95

cally, a significant improvement in all three indicators was observed in middle size hospitals and in GH-HC.

Nevertheless, a small decrease was observed in the technical and pure technical efficiency of large hospitals between 2010-2011, but considering the structural reforms that took place in the NHS, those rates still remain satisfactory (Table 2.1).

• Health Care Region efficiency

The efficiency of NHS hospitals has increased during the years 2009-2011 (Table 3 for TE), but a stagnation with small fluctuations was shown in the three efficiency indicators from 2010 to 2011.

In detail, efficiency improvement has been observed since 2010 in the 2nd, 4th, and 7th HCRs for large hospitals as well as in all HCRs, except the 6th and the 7th for the middle-sized hospitals. The indicator of PTE declined in the 3rd HCR for large hospitals and in 6th and 7th for large and middle-sized hospitals.

Furthermore, the SE in all three hospital categories ranges at satisfactory levels, with the exception of certain interventions which were required in some hospitals. According to the specific method used to estimate the efficiency, it can be concluded, that most hospitals of the country appear to have a good or even an ideal size.

Interventions for further progress seem to be necessary primarily for the large hospitals of the 2nd and 4th HCRs. Even though they have shown an increase in TE, PTE and SE, compared to the 2009 results, they still remain below the national average.

Regarding middle-sized hospitals, a greater effort for improvement and progress must be made by the Hospital Administrations in the 6th and 7th HCRs, particularly regarding technical efficiency which presented a decrease of 4% and 3% respectively since 2010.

Moreover, moderate efficiency scores are recorded in the secondary care hospitals of the 2nd HCR (mainly of the Aegean islands), which nevertheless showed a spectacular increase since 2009 in all three performance indicators, however with a small decline since 2010, which is attributed mainly to two general hospitals of this HCR, decrease of 7% and 11% between years 2010-2011.

Discussion

By comparing NHS data of three years (2009-2011), a remarkable increase in NHS hospitals' efficiency is noticeable. Many hospitals with initially low or relatively moderate efficiency have succeeded to increase their efficiency scores significantly and produce their outputs in a more rational way. Without a doubt, this kind of improvement was a difficult task considering the spending cuts, the constant pressure for the immediate adoption and implementation of structural changes in all fields especially in health care sector.

On the other hand, a decrease of technical efficiency of some University hospitals, except of one hospital of the 6th HCR, should not be overlooked. Furthermore, Cancer (anticancer and tumour) hospitals, in spite of their special role, managed to be equally efficient, compared to the other General hospitals. Interventions seem necessary

in tertiary care hospitals, mainly in hospitals with a large volume of patients with serious nosological incidents.

In conclusion, it could be noted that a redistribution of inputs in several hospitals is essential for a more efficient and effective use of the potential of these hospital units. Specifically, a redistribution of expenditures is imperative, as well as addressing the waste of hospital resources with a more reliable monitoring and supervision by the Authority.

This article has made an effort to analyze quantitative data of NHS. The restrictions of the study go beyond relative DEAs, i.e. quality has not been examined. However, health care reforms imposed for the last two years in the Greek NHS seem to have a positive effect on hospital efficiency, due to regulations on management, financial audit, logistics' control, procurement modernization, eHealth applications, monthly evaluation of Chief Executive Officers and their budgets and DRGs' establishment. The development of ESY.net created a benchmarking approach between hospitals, which was totally unknown in the previous years and created high costs.

The integration of all public finances and provision contracting out in a single fund (EOPYY), and further reorganization of NHS must be the next steps in 2012 and 2013 in order to achieve better performance levels, while the access, quality and internal development of health services (via ESPA) have been completed.

Finally, a strategy for Primary Health Care should be established, focusing on creating an integrated system of Primary Health Care in each region, particularly in large cities, with a minimum set of services, implementing and strengthening the role of general practitioners / family doctors and linking with programs and expert groups for chronic diseases. In addition to these actions, NHS Health Centres will sign contracts with EOPYY, as well as small hospitals will be converted to complete Urban Health Centres or Rehabilitation Centres.

The purpose of these actions is to create a network of Primary Health Care units and coordinate common actions with the rest of the health units / services in the health system. Finally, these actions will aim hospitals to be more effective focusing on secondary and tertiary care.

Conflict of Interest

The corresponding author confirms that there are no financial or other relations that could lead to a conflict of interest.

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