Reforms in Health Information Systems and Comparative Variation in the Efficiency of a Greek Health Region

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Abstract
Objective of the study is to present the reforms in the Greek Health System during the Economic Crisis and to associate the variation in efficiency with the reforms.

Data Source. The Material used had been processed with the use of the Data Envelopment Analysis method and the results are presented and depicted with the aid of a new application.

Study design. The reforms in the Greek Health System during the Economic Crisis aim in the increase of the Health Units’ Technical Efficiency, which can be verified through methods for measuring the Efficiency of Organisations, such as Data Envelopment Analysis.

Data Collection/ Extraction Methods. The Method used for the study includes the literary review of reforms already implemented by the Greek Government on Public Sector Health Units during the Economic Crisis in Greece.

Principal Findings. The study’s results show the negative variation in the Technical Efficiency of the Health Units of a Greek Financial Region during the Economic Crisis.

Conclusions. The study’s results include the interpretation of the negative variation in the Technical Efficiency of the Health Units of the Greek Financial Region during the Economic Crisis.

Keywords: Health Information Systems, Efficiency, Data Envelopment Analysis, Inflows/outflows, Health Reforms.

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1 Introduction

The Economic Crisis requires reforms and crucial changes in the operation of enterprises and organisations in order to address the ills and failures that threaten their fundamental values and structures and which led to the emergence of the Economic Crisis (Rosenthal & Kouzmin, 1997 [16]). Wilson and Eilertsen (2010) [17] demonstrated the relationship between Strategic Planning and the successful response to the crisis by reducing costs and increasing revenue, namely by increasing the efficiency of organisations. The Health Information Systems (H.I.S.), in the framework of an overall strategic plan, reduce the time required for applications and health procedures. This results in improved efficiency and effectiveness of health professionals in their daily work (Danzon and Furukawa, 2000 [5]). The most significant benefit of e-health applications is the rational management and conservation of Health Units’ resources (Menachemi et al., 2006) [12].

To assess the work of reforms with the impact of introducing HIS on Efficiency, an indisputable Efficiency measurement method should be applied. To measure the efficiency of Health Units, the most important and most frequently used method is Data Envelopment Analysis (DEA), which is a non-Parametric method (Ray, 2004) [15].

Farell (1957) [8], originally developed DEA and defined Technical Efficiency and Allocative Efficiency. Technical Efficiency was defined as the combination of the production factors determined by the production function. Productive factors produce the maximum amount of outflow without any wasting. Allocative Efficiency determines the combination of production factors with given values, so as to minimise production costs (Farell, 1957: 254).

Charnes, Cooper and Rhodes (1978) [4] gave DEA its definitive form. They defined the Decision Making Units through a link between economic and engineering approaches to profitability and were the first to study the application of the method for non-profit organisations as well as for businesses. They introduced the Production Probability Set (PPS) concept as a threshold that identifies the efficient or non-efficient units. Thus, they were the first to set Technical Efficiency with the following Formula:

\[
\text{Efficiency} = \frac{\sum_{r=1}^{s} UrYr}{\sum_{i=1}^{m} NiXij}
\]

\(i\) is the footnote of entries \((i = 1,2,\ldots,m)\)

\(j\) is the annotation of DMUs \((j = 1,2,\ldots,n)\)

\(r\) is the annotation of exits \((r = 1,2,\ldots,s)\)

\(Xij\) is the i entry of j DMU

\(Yrj\) is the r exit of j DMU

\(s\) is the number of exits

\(m\) is the number of entries

\(n\) is the number of DMUs

From this relation, they defined the Technical Efficiency of each unit (DMUo) if we set \(j = o\) and the limitation that the Technical Efficiency is \(<= 1\).

Based on the above, Charnes, Cooper and Rhodes defined the CCR model by maximising outflows or minimising inflows. In the case of minimising inflows, the formula is as follows:

\[
\text{Minho} = \sum_{i=1}^{m} NiXio, \text{limitations: } - \sum_{r=1}^{s} UrYrj + \sum_{i=1}^{m} NiXij >=0 \text{ and } \sum_{r=1}^{s} UrYro=1.
\]

with \(Ni> e, Ur> e\), where \(e\) a minimum non-zero amount.

Banker, Charnes and Cooper (1984) [1] developed the BCC model to measure efficiency through the relation between income and expenses. The resulting yield of a DMU is always at least equal to that given by the CCR model. DMUs with the lowest entry levels or the highest output levels are rated as effective. The
formula for the BCC model, which refers to the variable return to scale VRTS (outflows do not vary according to inflows) is a further restriction placed on the CCR model (steady return to scale) as follows:

$$\sum_{j=1}^{n} l_j = 1$$

By implementing the DEA method and verifying with other efficiency measurement methods, about five thousand studies evaluated the effectiveness of Decision Making Units. The literature review shows that a variety of studies in several countries have linked the introduction of H.I.S. to the variation of the efficiency of Health Units. Some of these studies find a correlation between the application of Health Information Systems and the change in the efficiency of Health Units, while others do not. We investigated literature and based on this investigation, some studies on the measurement of the efficiency of Health Units and the correlation with the introduction of the HIS, are shown here.

Borden (1988) [2], used the DEA method in 52 hospitals in New Jersey during the period 1979-1984, finding no change in Technical Efficiency as a result of the introduction of DRG Information Systems. During their survey of 349 urban hospitals, Lee & Wan (2003) [10], found that the completion of the information system shows a statistically significant correlation with the DEA technical efficiency scores. Chaudry et al. (2006) report that the introduction of H.I.S. increases efficiency through enhancement of patient monitoring and decrease of medication errors. Chern and Wan (2000) used the DEA method in 80 hospitals in Virginia without noticing any significant statistical difference in technical efficiency and the impact of DRG Information Systems on the efficiency of the hospitals. Dismuck and Sena (1999), through use of the DEA method, found a correlation between a percentage of cases on which the DRG Information Systems were implemented and a positive influence on productivity. Pizziferri et al. (1999) measured the H.I.S. correlation with the time spent on examination of patients resulting in prevention of complications, which affects the duration of hospitalisation (Kurvher et al., 2005).

2 Reforms in the Greek H.I.S. during the Economic Crisis and their effect on input - output efficiency measurement

The effects of the reform provisions for the implementation of the Health Information Systems (H.I.S.) during the period of the Greek Economic Crisis on Public Health Units of the Greek Health System are shown in Table 1. The reform provisions affect efficiency through avoidance of examinations which intensify artificial demand, the consequent reduction of personnel and the impact on the duration of hospitalisation (L.3892/10) and the optimal and economical supply of materials and services (L. 3918/11) which affects the duration of hospitalisation. Also, by saving time and resources through other tasks being performed by the staff, due to the implementation of M.I.S. PESYP of the Peloponnes - Patient Management, Medical Records and acts (Corinth General Hospital, 2012), which affects the number of days of hospitalisation and the average duration of hospitalisation, through timely and effective diagnosis and treatments and avoidance of unnecessary imports within the Health Units. Additionally, through comparison of the efficiency of Units and cost reduction through the Double-entry Management Information System, according to AP 94064/10.01.2012 circular of the Ministry of Health, automation of the purchasing process, with consequent reduction of supply time and the associated administrative costs which was realised by L. 4155/13 - ESIDIS Information System. The number of days of hospitalisation and the average duration of hospitalisation are affected by the implementation of e-Health due to the faster recovery of patients due to fast and secure administration of the appropriate treatment, which operates through the institutional e-governance reforms, the use of Health information with the implementation of L. 4213/13. Implementation of telemedicine in Health Units, Law. 4254/14 (subparagraph f.20) reduced the needs of patients’

Table 1: Table showing the Effect of reform provisions regarding Information Systems on inflows and outflows of models used for the measurement of efficiency of Public Sector Health Units’ systems.
Law 4238/14 implemented the keeping of personal electronic health files. The Personal Electronic Health Record for all Greek citizens was introduced. The timely and effective information on the patient’s previous history results in the rapid and effective treatment thereby reducing the number of hospitalisation days and the average length of hospitalisation and also reduces the number of patients being hospitalised and patients being admitted into hospital.

The inflows and outflows used in the study are also shown in Table 1 and were selected following a literature review.

Chaudhry et al. (2006) [3] conclude that the costs of the H.I.S. cannot be calculated accurately due to gradual implementation and technical support, so it is best to use non-financial data in the DEA study. Table 2 shows some studies which have used inflows and outflows which were selected among others for our own research.

<p>| Table 2: Inflows-outflows used in studies on efficiency (Writers, 2016) |</p>
<table>
<thead>
<tr>
<th>Researchers</th>
<th>Description</th>
<th>Inflows</th>
<th>Outflows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Comparative Change in Efficiency of Health Units of the 6th Health Region for 2010-2014

The Greek Economic Crisis, which emerged in 2010, brought about a series of new measures that were implemented in the health sector, among others. In the health sector, the Government made a radical reform involving the introduction of H.I.S and the redesign of organisational processes. Based on the above data regarding inflows and outflows used in Health Unit Efficiency studies based on literature, we selected the inflows and outflows of our study as follows: We select Developed Beds, Days of hospitalization and Average length of stay as inflows, and Patients’ admission, Number of inpatients and Coverage rate of hospital beds as outflows. We only designate Patients’ admission as Non-Discretionary. Using these inflows and outflows we entered the data in the EMS 130 program, as they were given to us following a contract with the Hellenic Statistical Authority for the first years of the Economic Crisis. We then calculated the Overall Technical Efficiency and the Variation Rate of Overall Efficiency and presented the results as shown below.

Table 3 shows the comparison of the overall technical efficiency of units of the 6th Health Region, as calculated by the DEA method (Farantos & Koutsoukis, 2016 [7]) with the aid of a new DEA application (Farantos, 2015 [6]). In table 3, one can observe a continuous decrease in the overall relevant efficiency during the period of the economic crisis. However, the efficiency decrease rate exhibits a marked decline during the last observed period (between 2013 and 2014), indicating that the decline in efficiency tends to zero.

<table>
<thead>
<tr>
<th>Borden (1988)</th>
<th>Efficiency of introduction of DRG Information System Methods</th>
<th>Number of nurses and number of beds</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChernandWan (2000)</td>
<td>Efficiency of introduction of DRG Information System Methods</td>
<td>Number of beds and number of employees</td>
<td>Number of discharges from in-hospital treatment</td>
</tr>
<tr>
<td>Dismuke and Sena (1999)</td>
<td>Two-stage DEA method and analysis of Regression</td>
<td>Number of surviving patients’ discharge per DRG category and number of deceased patients’ discharge per DRG category</td>
<td></td>
</tr>
<tr>
<td>Tierney et al. (1993) και Overhage et al. (2001)</td>
<td>Study on introduction of systems based on computers for medical information</td>
<td>Duration of hospitalisation</td>
<td></td>
</tr>
<tr>
<td>Gerdthametal. (1999)</td>
<td>Two-stage DEA study on Health Units</td>
<td>Number of beds</td>
<td>Number of discharges</td>
</tr>
</tbody>
</table>

Table 3: Comparison of overall technical efficiency and efficiency measurements of units of the 6th Health Region (model 1) for the years 2012 - 2014
Figure 1 shows the variation of the Efficiency of Health Units of the 6th Health Region during the Economic Crisis. One can easily observe that at the beginning of the Economic Crisis the variation rate (decrease) of Efficiency increases resulting in the curve acquiring the characteristics of a sharp decline. But then, and as the Economic Crisis unfolds, the Efficiency reduction rate decreases and although Efficiency slowly decreases, it tends to stabilize around a certain value.

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall Relevant Efficiency</th>
<th>Variation rate of Overall Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>87.83%</td>
<td>-</td>
</tr>
<tr>
<td>2011</td>
<td>86.55%</td>
<td>- 1.4%</td>
</tr>
<tr>
<td>2012</td>
<td>83.08%</td>
<td>- 5.4%</td>
</tr>
<tr>
<td>2013</td>
<td>77.78%</td>
<td>- 6.3%</td>
</tr>
<tr>
<td>2014</td>
<td>76.54%</td>
<td>- 1.5%</td>
</tr>
</tbody>
</table>

It has been observed that crises reduce the efficiency of organisations under their influence during these crises (Movahedi et al., 2007: 1569 – 1579 [11], Ozcan-Gunai&Tektas, 2006: 418-431). So, this decrease in efficiency observed by the survey may very well be temporary and reflect the period from the beginning to the peak of the crisis.

4 Conclusion

The conclusion drawn from the diagram is the decrease of Overall Relevant Efficiency of the Units with a simultaneous decrease of the percentage of efficient units. This can be explained as being due to the reform’s transition period, the merger of some units, the staff’s reaction to changes and in general to the transition function which causes a temporary decrease of efficiency before it is followed by the next function period, during which the efficiency of each unit will rise to the maximum, resulting in the overall relevant efficiency appearing higher when compared to the previous one. So, the question that arises is: why did the efficiency of the units decrease under the influence of the reforms which took place during the crisis? The answer to this question is given by the theory of management of changes in organisational processes. Indeed, according to the main models of change management, Elisabeth-Kubler Ross’s model with the change curve,
Lewin and Kotter’s model, where the efficiency of an organisation reduces during the first stages of change due to the resistance of workers and worker groups to change prior to the recovery period under new conditions, at which time efficiency increases. The introduction of changes in any information system, along with the changes in organisational processes, distribution and organization of work caused by new technology, initially result in malfunctions. It is up to future studies after the final exit from the crisis to once and for all confirm or disprove the increase of efficiency as a result of the Administration’s reforms.

References


