Regional human development index and performance of social security hospitals in Iran

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Social security is a public right and in this regard hospitals play an important role in the health sector of the society through serving therapeutic and health services. The goal of this research is to answer the basic question of, what relationship is there between the human development index (HDI) of the regions and the efficiency level of hospitals working in those specified regions. The data envelopment analysis (DEA) method is used to measure the efficiency level of 65 hospitals owned by the social security organization (SSO) of Iran, including small hospitals (working with lower than one hundred active beds) and large hospitals (working with over one hundred active beds) during the period of 2007 to 2009. Further, the relationship between human development index and technical efficiency level of hospitals in the provinces has been analyzed. Results show that the average technical efficiency of small and large hospitals in low and medium HDI provinces (0.912 and 0.937) are more than the average technical efficiency of hospitals in higher HDI provinces (0.870 and 0.887). Therefore it is recommended that social security organization should preferably spread its hospital services by more concentration on provinces with lower HDI and higher density of population living under the coverage of organization’s provident funds. This will eventually puts its positive effects on per capita income of people, as well as more equitable distribution of income.

Keywords: Hospital, human development index, efficiency and data envelopment analysis.

INTRODUCTION

Using health care system and possibility of access to the services related to personal health are amongst the human rights and people's expectancy of civil societies. For this purpose, health and therapeutic department is the administrator to provide a systematic collection of activities and practical operations to supply and improve physical, mental and social health level of society in the form of social affairs. On this direction, legal organizations of the social security by collecting, arranging and gathering sources in different forms, and buying service from the health services providers in public, private and semi-public departments, allow the people under their coverage to have equal and wide access in the health department. Among different organizations active in the health department, after the health ministry, Iran's social security organization is the second organization in term of activity range and largeness which provides for the people insured services including therapeutic and health services, retirement, pension and disability.

Social security organization therapeutic department, by giving more emphasis on hospital services during the years of its activity has taken effective steps in this regard and tried to provide for the services users, maximum satisfaction with the facilities it has. In this organization, hospital cares are done through two ways of direct cure system (the hospitals under ownership and management of the organization itself) and indirect cure system (in form of buying hospital and therapeutic services from other service providers). In other word, either the organization itself takes action as a therapeutic service supplier, or undertakes the applicants' expenses by directing them to the free market of therapeutic services. Evidently, inefficiency and ineffectiveness in such an important service department of the society not only reduce the quality of life, but also preclude improvement in other departments, increase social injustice and inequalities and subsequently reduce the level of social welfare and development (Sajadi and Karemi, 2009).
During the study course, meaning the years 2007 to 2009, the social security organization has presented health and therapeutic services in different regions of Iran, using 69 hospitals covering about 8035 active beds. The goal of the study is to answer the important and basic question of whether the technical efficiency level of hospitals under social security organization is the same in term of enjoyment in different regions, and what relationship is there between the human development index (HDI) of the region and technical efficiency level of hospitals?

LITERATURE REVIEW

Modern growth theories introduce the factor of "human resource" as development origin and deem the human capital quality improvement as the most valid condition of move towards optimum economic development. The consensus is based on the issue that the societies having emphasized human capital formation have also had better function in terms of economic growth, employment, poverty reduction and equal distribution of income. Today, human development index (HDI) and its growth coefficient has a significant portion in preparing the current situation and function of the organization being investigated with the same best organizational operation; in such a way one can say that, efficiency indicates how the organization has used its sources on the direction of production as compared to the best function in a period of time. Wang et al. (2010) believe that, competency and efficiency are considered as two important and inseparable indexes in measuring economic situation of a firm. While a producer's efficiency refers to the ratio of outputs to inputs in the production process, competency refers to relative efficiency of a firm comparing to other firms during a period of time or place or both. To measure efficiency level of the organizations, two types of methods are used including parametric methods such as stochastic frontier analysis (SFA) and nonparametric methods such as data envelopment analysis (DEA). In this study, it is emphasized to use the second method. The main goal of using DEA method is to answer the important question that to what extent, one may increase the amount of finite values of outputs or the organization's production without changing the values used in inputs needed for the organization?

Bhat et al. (2001), in their study using DEA method, did a comparative investigation into technical and specialized efficiency of regional hospitals and the hospitals receiving public assistances in Gujarat state of India. Statistical community of this research composed of 47 hospitals; number of physicians, nursing and paramedical, administrative and technical staff, number of beds, medicine costs, physical infrastructure, equipment list, laboratory working hours in a week and the maintenance costs were used as inputs; number of inpatient and outpatient services and laboratory cases were utilized as outputs. The mentioned research concluded that among 47 hospitals being studied only 22 hospitals were efficient.

Bakhtiary et al. (2006) in their study named "investigating province's position of Iran in term of human development index", described the structure of human development index and its complementary indices in provinces and made a comparative investigation in this regard. Results showed that in the ground of common human development index and based on the statistics of the year 2001, the provinces Tehran, Esfahan, Gilan, Yazd and Semnan went into the higher classifications. In another study named "human development in Iran", Sadeghi et al. (2007) investigated human development situation of Iran through HDI measurement in all the provinces during the years 1996 and 2001. The investigations showed that in most of the provinces the situation of human development has improved in 2001 as compared to 1996 and the most important factor of HDI increase is the educational and health facilities improvement in the country. They have found also that the difference in human development index in the provinces is very high and all the provinces do not enjoy the same level of education, health and income facilities.

Akazili et al. (2007) in an article named "using data envelopment analysis to evaluate technical efficiency in general health centers of Ghana", investigated the
efficiency of 89 random cases among 622 health centers of Ghana which was reported in 2004. In their study, technical efficiency has been separated into two parts, that is, management and scale efficiency, assuming variable return to scale. For this purpose, four inputs were used; number of workforce including clinical and non-clinical personnel, number of beds, beds of newborns and medicine cost (Akazili, 2008). Five items including all the outpatient visits, number of pre-birth visits, number of deliveries, number of vaccinations, and number of inpatient visits were used as outputs. The results showed that 65% of these centers have a low level efficiency, so it can be said that averagely about 35% of the sources have been used optimally. Jojes and Emrouznejad (2008) also in a study with the goal of "evaluating Angola’s hospital efficiencies", and considering that 60% of the budget of Angola’s health ministry is spent on creating health care facilities, investigated 28 urban public hospitals working under the municipality. Results showed that the urban hospitals averagely enjoyed a growth of 5.4% during the course of research (2000 to 2002). They referred to improvements rather than innovations to increase efficiency.

Sahin et al. (2011), in a study called "evaluating efficiency of public hospitals in different provinces of Turkey; using data envelopment analysis", investigated the efficiency of 80 public hospitals in Turkey. In this study, number of beds, workforce in four levels and hospitals’ costs were used as inputs; mortality rate was used as a unit to measure quality of services, and also number of the inpatients and outpatients was utilized as the outputs. Results showed that 55% of public hospitals being studied have relatively acted inefficiently. Also, analyzing inefficient hospitals shows that in most of them there is employing experts and other personnel more than needed comparing to the other efficient hospitals. In another attempt, Sepehrdoust (2011a) studied "the factors influencing regional development in view of health indexes". He first measured development level of the provinces based on enjoying equal access to important health-therapeutic indexes. The results of principal component extraction influencing regional differences in view of health and therapeutic facilities showed that about 76% of the variances available in regional differences derive from unbalanced distribution of 5 components including specialists (0.749), urban health centers (0.612), rustic health centers (0.853), number of urban sewage branches (0.742) and health homes (0.605) in provincial regions of the country.

MATERIALS AND METHODS

In this research, linear programming is used to measure technical efficiency of hospitals as multi decision maker units (DMU). Each decision maker unit includes a structure of several inputs and outputs. So, to evaluate n decision maker unit, it is supposed that each of them uses different values of m inputs to produce s outputs, and especially each DMU uses input values of \( X_j =\{x_{ij}\} \); (i = 1, 2, ..., m) to produce output values of \( Y_j =\{y_{rj}\}; (r = 1, \ldots, s) \), taking \( x_{ij} > 0 \) and \( y_{rj} > 0 \). So for the supposed firm we have:

\[
\begin{align*}
    \text{Max} & \quad \sum_{r=1}^{s} u_{rp} Y_{rp} \\
    \text{s.t.} & \quad \sum_{i=1}^{m} v_{ip} X_{ip} = \sum_{r=1}^{s} u_{rp} Y_{rp} \leq 1 \quad (j: 1, 2, \ldots, n) \\
    & \quad \sum_{i=1}^{m} v_{ip} X_{ij} \leq \sum_{r=1}^{s} v_{rp} Y_{rj}, \\
    & \quad u_{r}, v_{i} \geq 0.
\end{align*}
\]

In the preceding relations, \( X, Y, u \) and \( v \) variables are respectively the values of inputs, outputs, weights of input variables, and weights of output variables. To obtain optimum answer for each unit and by some mathematical operations, the preceding relations turn into multiple form of input-oriented CCR model (Charnes et al., 1978).

\[
\begin{align*}
    \text{Max} & \quad \sum_{r=1}^{s} u_{rp} Y_{rp} \\
    \text{s.t.} & \quad \sum_{i=1}^{m} v_{ip} X_{ip} = 1 \quad (j: 1, 2, \ldots, n) \\
    & \quad \sum_{r=1}^{s} v_{rp} Y_{rj} \leq \sum_{i=1}^{m} \mu_{ip} X_{ij} , \\
    & \quad \mu_{r}, \nu_{i} \geq 0.
\end{align*}
\]

In order to achieve the goals of the study, 65 active hospitals of social security organization in different provincial regions of Iran, including small hospitals with less than 100 active beds (28 hospitals) and large hospitals with more than 100 active beds (37 hospitals) were investigated for the years 2007 to 2009. On the other hand, the regions in Iran were divided into three groups; provinces with high HDI level, including Tehran, Khuzestan, Yazd, Semnan, Markazi, Isfahan, Oazvin, Bushehr, Mazandaran, Hormozgan, Kerman, Qom, Gilan, Fars and Elam, provinces with medium HDI level, including Eastern Azerbaijan, Khorasan, Chaharmahal and Baktiary, Lorestan, Kohkilooeyeh and Boyer Ahmad, Hamedan, Kerman shah and Zanjan and finally provinces with low HDI level, including Western Azerbaijan, Ardabil, Kordestan and Sistan and Baluchestan (Sadeghi et al., 2007). At present Iran’s territory consists of 30 provinces, which are governed by a local centre, usually the largest local city (Figure 1). Provincial authority is headed by a governor (Ostandar), who is appointed by the Minister of Interior, subject to approval of the cabinet. Regional planning is directed through the budgeting system which is annually
proposed by the central government and approved by the parliament (Sepehrdoust, 2009).

Each hospital unit being studied in the model of efficiency measurement such as data envelopment analysis (DEA) is called an organizational decision making unit (DMU). To gather information, the published sources such as social security organization statistical database, ministry of health and medical education, and the organization of provinces’ health management were mostly used. The research variables were divided into two groups of inputs and outputs. Inputs include number of fulltime physician staff, number of fulltime nursing staff, number of other fulltime personnel (representative of human resource factor) and the index of average active bed (representative of capital factor). Outputs include number of outpatient reception, number of inpatients, number of surgeries, and the average of bed rotation used. Hospital outpatient is a patient who is admitted to a hospital or clinic for treatment that does not require an overnight stay. But inpatient is a hospital patient who occupies a bed for at least one night in the course of treatment, examination, or observation compare. In this regard, the term “inpatient hospital services” means the services furnished to an inpatient of a hospital including; bed and board, nursing services, diagnostic or therapeutic services, medical services provided by a physician, resident, or intern and other hospital facilities (Social Security, 2011).

To measure technical efficiency, first the data envelopment analysis with the assumption of constant return to scale (CRS) and based on input-oriented theory (CCR model) was used. Input-oriented theory is selected because in the organizations like hospital, outputs are not in the control of managers, but inputs are still in the control of hospitals managers. Then, to separate technical efficiency into its parts meaning scale and management efficiency, Banker, Charnes and Cooper (BCC) model is used with the assumption of variable return to scale (VRS).

RESULTS

The results derived from measuring the efficiency of social security hospitals show that, hospitals having the capacity more than 100 active beds, enjoy higher average rate in technical efficiency (TE = 0.912) as compared to the average efficiency rate of hospitals having the capacity less than 100 active beds (TE = 0.887), but the percentage number of small hospitals which are efficient (28.5%) is more than large ones (16.2%).

As far as the relation between efficiency scores of hospitals and regional HDI is concerned, the results show that, in the provinces with higher HDI, technical efficiency mean of large social security hospitals is 0.887 and only 10.52% of them enjoyed full efficiency score. It means that among 1000 units of available capacity in this group of hospitals only 887 units have been utilized very well and 113 units have been remained useless in practice and they’re required to reduce 11% of their surplus costs to reach an efficient situation. While, technical efficiency mean of small hospitals is 0.870 and only 16.2% of them enjoyed full efficiency score. It means that among 1000 units of available capacity in this group of hospitals, only 870 units have been utilized and 130 units have been remained useless in practice and they’re required to reduce 13% of their surplus costs to reach an efficient situation. It means the current output values are reachable by lower input values.

On the other hand, the results in provinces with low and medium HDI show that the average technical efficiency score of large social security hospitals is 0.937 and only 22.22% of them enjoyed full efficiency score. It means that among 1000 units of available capacity in this group of hospitals only 937 units have been utilized and 63 units have been remained useless in practice. Also, the average technical efficiency of small hospitals was 0.912 and 50% of them enjoy full efficiency. Table 1 shows matrix of technical efficiency mean values in Iran’s social security hospitals separated in provinces having high, low and medium HDI during the year 2007 to 2009.

With due attention to the presented definition of efficiency index in which nominator includes balanced outputs and denominator includes balanced inputs, we’ll have following relation (Sepehrdoust, 2011b):

\[
\text{Efficiency} = \frac{\sum_{i=1}^{n} ax_i + bx_i + cx_i + dx_i}{ex_i + fx_i + gx_i + hx_i}
\]

In order to investigate the factors influencing efficiencies, the coefficient means of factors, meaning the parameters a, b, c, d, e, f, g and h as mentioned in the preceding equation, have been obtained for efficient units during the study course and compared with each other. The results
Table 1. Technical efficiency of hospitals in provinces with different HDI (2007 to 2009).

<table>
<thead>
<tr>
<th></th>
<th>Hospital’s efficiency mean in Provinces with high HDI</th>
<th>Hospital’s efficiency mean in Provinces with low and medium HDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitals with small activity scale</td>
<td>0.870</td>
<td>0.912</td>
</tr>
<tr>
<td>Hospitals with large activity scale</td>
<td>0.887</td>
<td>0.937</td>
</tr>
</tbody>
</table>

Table 2. Factors influencing social security hospital’s efficiency (2007 to 2009).

<table>
<thead>
<tr>
<th>Importance ranking</th>
<th>Small hospitals</th>
<th>Large hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factors Name</td>
<td>Importance coefficient</td>
<td>Factors Name</td>
</tr>
<tr>
<td>1</td>
<td>Number of physician</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>Bed rotation mean</td>
<td>0.228</td>
</tr>
<tr>
<td>3</td>
<td>Number of inpatients</td>
<td>0.223</td>
</tr>
<tr>
<td>4</td>
<td>Number of outpatients</td>
<td>0.192</td>
</tr>
<tr>
<td>5</td>
<td>Active bed mean</td>
<td>0.168</td>
</tr>
<tr>
<td>6</td>
<td>Number of surgery</td>
<td>0.163</td>
</tr>
<tr>
<td>7</td>
<td>Other personnel</td>
<td>0.117</td>
</tr>
<tr>
<td>8</td>
<td>Number of nursing staff</td>
<td>0.098</td>
</tr>
</tbody>
</table>

of investigating factors influencing efficiencies and their importance ranking in small and large hospitals of social security are presented in Table 2. The comparative investigation showed that in large hospitals, the average active bed has more impact on the efficiency level of these hospitals than other factors which indicates the importance of physical capital variable in this group of hospitals; while in small hospitals, number of physician staff has more impact on the efficiency level of hospitals than other factors which indicates the importance of expert human capital in this group of hospitals. With regard to investigating the relationship between efficiency index and hospital unit’s size, total factor productivity (TFP) index is used. In this method and by the help of distance functions, total factor productivity changes has been investigated in its part, meaning technology, management and scale efficiency. Evidently, if the amount of efficiency index and its components is less than one, based on the method of minimizing production factors, it indicates productivity increase over the period of time and if it is more than one, it implies productivity decrease in the course of time period (Emami, 2005).

The figures related to total factor productivity and its components in the regions with high HDI, indicate that during the study course total factor productivity in small and large hospitals faces negative changes. These figures in the regions with low and medium HDI in large hospitals had also negative changes, but in small hospitals they enjoyed positive changes. This issue indicates that manager’s serious effort in small hospitals of the regions with low and medium HDI helps to increase the efficiency of the units under their management (Table 3).

Conclusions

Social security is a public right which should be implemented for the sake of all individuals of the society by the central government. That is why the government in most of the countries is legally committed to finance the required services and protections by motivating public revenues and collaborations. For this purpose although, many institutions and organizations have always been the source of prominent assistances and services to the people, but they could never been much effective in their mission due to lack of an extensive and trustee organizational structure. Efficient managerial skills are needed to provide the possibility of continuous managing, monitoring and evaluating the working status of the service provider organizations. Among the organizations, social security organization (SSO) of Iran as the central organization of comprehensive social security and welfare system has got a significant importance on the direction of providing society’s job security, redistribution of income and improving people’s health. The SSO is a social insurer organization with the major mission on compulsory coverage of wage-earners and salaried workers as well as voluntary coverage of self-employed persons. That is a nongovernmental organization which is solely financed by the contributions (with participation of insured (7%), employer (20 to 23%) and government (3%).

The present research is an effort to measure technical efficiency of hospitals under the coverage of SSO during the years 2007 to 2009 and to investigate also the relationship between different efficiency level of the hospitals and HDI level of the regions in which the
The social security organization's move to provide hospital services in the regions having more emigrant workers is considered as a purposeful action towards improvement and more equal distribution of income in the society.

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### Table 3. TFP change averages in social security hospitals (2007 to 2009).

<table>
<thead>
<tr>
<th>Hospitals</th>
<th>(TFP*)</th>
<th>Technical efficiency changes</th>
<th>Technological efficiency changes</th>
<th>Managerial efficiency changes</th>
<th>Scale efficiency changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provinces with high HDI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Hs</td>
<td>1.016</td>
<td>1.022</td>
<td>0.993</td>
<td>1.004</td>
<td>1.015</td>
</tr>
<tr>
<td>Large Hs</td>
<td>1.005</td>
<td>0.984</td>
<td>1.02</td>
<td>0.979</td>
<td>1.005</td>
</tr>
<tr>
<td>Mean</td>
<td>1.011</td>
<td>1.003</td>
<td>1.007</td>
<td>0.992</td>
<td>1.010</td>
</tr>
<tr>
<td>Provinces with low and medium HDI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Hs</td>
<td>0.967</td>
<td>0.966</td>
<td>0.997</td>
<td>0.986</td>
<td>0.978</td>
</tr>
<tr>
<td>Large Hs</td>
<td>1.017</td>
<td>1.01</td>
<td>1.007</td>
<td>1.009</td>
<td>1.000</td>
</tr>
<tr>
<td>Mean</td>
<td>0.992</td>
<td>0.988</td>
<td>1.002</td>
<td>0.998</td>
<td>0.989</td>
</tr>
</tbody>
</table>

*Total factor productivity