Technical efficiency and resources allocation in university hospitals in Tehran, 2009-2012

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Abstract

Background: Assessment of hospitals' performance in achieving its goals is a basic necessity. Measuring the efficiency of hospitals in order to boost resource productivity in healthcare organizations is extremely important. The aim of this study was to measure technical efficiency and determining status of resource allocation in some university hospitals, in Tehran, Iran.

Methods: This study was conducted in 2012; the research population consisted of all hospitals affiliated to Iran and Tehran medical sciences universities of. Required data, such as human and capital resources information and also production variables (hospital outputs) were collected from data centers of studied hospitals. Data were analyzed using data envelopment analysis (DEA) method, Deap2,1 software; and the stochastic frontier analysis (SFA) method, Frontier 4,1 software.

Results: According to DEA method, average of technical, management (pure) and scale efficiency of the studied hospitals during the study period were calculated 0.87, 0.971, and 0.907, respectively. All kinds of efficiency did not follow a fixed trend over the study time and were constantly changing. In the stochastic frontier's production function analysis, the technical efficiency of the studied industry during the study period was estimated to be 0.389.

Conclusion: This study represented hospitals with the highest and lowest efficiency. Reference hospitals (more efficient states) were indicated for the inefficient centers. According to the findings, it was found that in the hospitals that do not operate efficiently, there is a capacity to improve the technical efficiency by removing excess inputs without changes in the level of outputs. However, by the optimal allocation of resources in most studied hospitals, very important economy of scale can be achieved.

Keywords: Technical efficiency, Resource allocation, Data envelopment analysis, Stochastic frontier analysis.

Introduction

One of the most important service sectors and indicators of development and social welfare is the health sector, of which its economic analysis is very important to policy makers (1). Nowadays, health systems are one of the largest sectors of the world economy. Universal healthcare spending makes up about 8% of gross domestic product (2). In most developing countries about 5 to 10% of government expenditure has been allocated to the health sector (3).

Government health spending in developing countries makes up for 3 to 4% of GDP. This figure is much more higher than that in developed countries, indicating govern-

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ments' significant role in meeting the healthcare needs of the community (4).

Among the various components of health systems, health care services are the most important factor in the cost growth in many countries (5). Hospitals consume about 50 to 80% of the budget of the health sector, and hire a large share of trained specialists of the health sector (3). In Iran, about 7% of GDP belongs to health spending (6) and about 40% of public health expenditure is allocated to hospital care (7).

To assess the efficiency and effectiveness of a healthcare system we have to measure the health system's management performance. Therefore, a good performance can confirm that a hospital has, efficient management and talent for optimal use of limited resources and thus should receive necessary and sufficient support to achieve better results (8).

The hospital industry cannot achieve economic efficiency unless technical efficiency is reached in hospitals. Technical efficiency is attained when hospital outputs are supplied with minimum inputs, or on the other hand, maximum production is related with the given inputs in the hospital (9).

Common methods to estimate the efficiency of health care systems include the data envelopment analysis (DEA) models, the stochastic frontier approach (SFA), the least squares regression and ratio methods. In some studies, the ratio methods are used for measuring efficiency, However, these methods are of use, where only one input and one output exists, but it cannot be a useful tool for economic analysis where multiple inputs and outputs are considered in a complex organization such as hospital (10). Thus, in this study data envelopment analysis and the stochastic frontier analysis were applied. Multi-factor productivity analysis model, which is used for measuring the relative efficiency of decision making units, and a set of non-parametric programming methods were used to estimate the boundaries of production and output (11).

Assessment of hospital performance by using DEA mathematical models is so important. In this type of evaluation, hospitals are ranked in a quite real and competitive environment and in order to create a strong incentive for increasing productivity and efficiency, efficient models and references are presented for inefficient hospitals (12). The SFA estimates the efficiency of the economic corporations within the industry by using of the integrated data and determining the production functions with the method of maximum likelihood.

In 2008, Rezapour and Asefzadeh in a study entitled "study of the economic efficiency of training medical centers affiliated to Qazvin University of Medical Sciences during the years 1998 to 2007, estimated the average technical, management and scale efficiency to be 0.90, 0.96 and 0.93, respectively. The results showed that 50% of centers in terms of effective use of data in the context of outputs performed efficiently (total technical efficiency= 1) and the remaining 50% were inefficient (1> total technical efficiency)(13).

In 2005, Gannon in a study entitled "calculation of the technical efficiency of public hospitals in Ireland during the years 1995 to 2000", showed that technical efficiency has been reduced from 0.96 for the years 1996 to 1995 to 0.94 in the period of 1999- 2000, by using of the data envelopment analysis (14).

Novin and colleagues in 2004 in a study entitled "nonparametric analysis of efficiency of hospitals and medical centers in Vietnam" studied 17 hospitals and 27 medical centers in different cities and provinces of Vietnam. In this study, the assumptions of constant returns to scale (CRS) and variable returns to scale (VRS) were used to evaluate efficiency values and Deap$_{2.1}$ software was used to estimate the efficiency. Findings suggested that the under study hospitals and medical centers were able to produce the same amount of current output by respectively 22.6% and 41.3% reduced inputs. The results of hospitals in different regions of Vietnam showed that geographical location had no effect on the technical

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and scale efficiency of hospitals in 2002. Based on these results, it was found that hospitals were more efficient than medical centers (15).

Puieg and colleagues (2000) examined the economic efficiency in 94 hospitals in Spain using data envelopment analysis and regression model. In this study, all types of technical, allocative, net management, scale, cumulative, non-cumulative, and economic efficiency were calculated. The results showed that economic inefficiency is 24.5%. This study represented that technical and allocative efficiency are independent of each other, and private hospitals, have higher efficiency than public hospitals (16).

Methods

This applied study was conducted in university hospitals affiliated to Iran and Tehran University of medical sciences during 2009 - 2012.

Needed data, such as human and capital resources information and also production variables (hospital outputs) were collected from data centers of studied hospitals and was registered at information sheets. Required statistical data for current study was panel data (combination of cross-sectional and time-series data). This form contains:

1. Human resources variables, including: physicians, nurses, and other non-medical personnel: administrative–financial, diagnostic–imaging, and supportive departments,

2. Capital variables including active beds,

and 3, output variables including the number of inpatients and the number of bed days admissions.

In this study, we used two types of models: DEA and SFA to assess the efficiency and situation of human and capital resources allocation.

Data envelopment analysis approach: In the DEA, we performed the analysis through Deap$_{2, 1}$ software with an "entry or input oriented model" under the assumption of VRS and in terms of minimization of inputs (since maximization of hospital out-

comes is not included in the manager's jurisdiction). In this study, VRS was chosen because the assumption of CRS is applicable just when a hospital performs at optimal scale (the flat part of the long-term average cost curve or envelope LRAC curve), but for some reasons including competition effects, constraints, and etc, some hospitals are not able to perform at optimal scale. Analysis of hospital efficiency at CRS can be used as a long-term goal and VRS can be considered as a short-term goal for inefficient hospitals. In this study, input-oriented model is separately applied for each hospital; this model minimizes the hospital sources and inputs by considering a certain level of current outputs as well as environmental problems, and suggests the amount that a hospital can minimize its resources and simultaneously maintain the same output and certain consequences.

Minimize R_n
$$w_1,...,w_N, R_n$$

Subject to:
$$\sum_{j=1}^{N} w_j y_{ij} - y_{in} \geq 0 \quad , \quad i = 1,...,I$$
$$\sum_{j=1}^{N} w_j x_{kj} - R_n x_{kn} \leq 0 \quad , \quad k = 1,...,K$$
$$\sum_{j=1}^{N} w_j \leq 1$$
$$w_j \geq 0 \quad , \quad j = 1,...,N$$

N: number of firms in the sample, y_{in}: The i product in the firm number n, I: number of outputs, X_{kn}: input k in the firm number n, K: number of inputs, E_n: technical efficiency of the firm number n and W_j: weights applied to the N firm (a N×1vector of constant values that indicate the weight of the reference collection).

In the case of minimizing the inputs, if the amount of scale efficiency (E_n/S_n) is less than 1, and E_n, R_n are equal, the firm has the increasing returns to scale and n is necessary to increase its size to achieve optimal scale. If the scale efficiency (E_n/S_n) is less than 1 and E_n is less than R_n, n firm has Decreasing returns to scale and is necessary to decrease its size to achieve optimal scale.

In the case of maximization of the outputs, if the value of scale efficiency (E_n/S_n) is greater than 1, there is a scale inefficiency. In this case, if $R_{n=} R_n$, the firm has increasing returns to scale and if $R_{n>} E_n$, the firm has decreasing returns to scale. It should be noted that you can measure and identify inefficiency to scale through Charnz, Cooper and Rhodes model by taking the sum of wj. If the optimal answer of the model is

$\sum_{j=1}^{N} w_j \geq 1$, it means that the scale of the firm is too large,

if $\sum_{j=1}^{N} w_j \leq 1$, so the scale is too small,

and

if $\sum_{j=1}^{N} w_j = 1$,

then the firm has operated in the most productive scale size (17).

Stochastic frontier analysis approach: In the stochastic frontier production function approach, we analyzed the data by Frontier$_{4,1}$ software through Cobb- Douglas Production Function.

$$LnY_{it} = \beta_0 + \sum \beta_j LnX_{jit} + (V_i - U_i)$$

Y: Production of hospital, X: vector of Production Factors, β: Parameter vector, U: the effect of inefficiency and V: random variable with normal distribution and independent from U.

If random error > the effect of inefficiency, then products will be at the beyond of the frontier production function.

In this study, inputs and outputs of the models for the studied industry were chosen as follows:

• *Inputs of the model:*
In this study according to different types of empirical studies on the hospital efficiency, two types of inputs were considered, including:

a) Human resources including doctors, nurses and health workers, diagnostic-imaging unit personnel and personnel of administrative and financial units of the hospital and

b) Capital resources including the number of hospital available beds for the studied models

• *Outputs of the model:*
In this study, index numbers of hospital inpatient admissions and inpatient bed occupancy rate are considered as the output for the model of DEA and for the stochastic frontier analysis; index number of inpatient admissions was selected as the output. In this study due to lack of information or incompleteness of key information and uncooperative staff; some hospitals were excluded, thus 19 hospitals were studied in a 4-year period.

Study limitations
We Assessed resources allocation and technical efficiency in studied hospitals through SFA and DEA approaches, though the results of study may be affected by using other methods. Since the hospitals outputs are not under the control, we could not use output-oriented model in DEA approach. Also, we selected some limited and mentioned variables as input or outputs of hospitals and it can be considered some other types of variables as input or output in explained approaches.

Results
The results of the DEA: According to Table 1, all hospitals had greater compared with the other types of managerial efficiency, in 2009. In most of the studied hospitals, scale efficiency was as equal as technical efficiency and in the rest of the cases it was even more. The results indicated that about 36.8% of surveyed hospitals were fully functional in terms of technical efficiency and technical efficiency was equal to 1 in these hospitals. In addition, in this year, in approximately 73.5% of the hospitals, technical efficiency was equal to 1 and in about 36.8% of the hospitals scale efficiency was 1. The lowest rate of technical and scale efficiency with 0.631 belonged to Razi Hospital and minimal managerial efficiency with 0.852 belonged to Ziaeian Hospital. Also, according to recent research findings, approximately 42.1% of the stud-

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Table 1. Results of the estimation of different types of efficiency of the studied industry in 2009

Hospital	Technical inefficiency	Managerial efficiency	Scale efficiency	Kinds of returns to scale*	Reference hospitals	Percent of reduction in inputs for achieving the given output
1. Arash	0.752	1.000	0.752	irs	1	24.8
2. Imam Khomeini	1.000	1.000	1.000	-	2	
3. Cancer Institute	0.936	0.940	0.997	drs	2,4,6,11	6.4
4. Baharloo	1.000	1.000	1.000	-	4	
5. Razi	0.631	1.000	0.631	irs	5	36.9
6. Roozbeh	1.000	1.000	1.000	-	6	
7. Zanan	0.763	1.000	0.763	irs	7	23.7
8. Sina	0.896	1.000	0.896	drs	8	10.4
9. Shariati	0.965	1.000	0.965	drs	9	3.5
10. Ziaeian	0.639	0.852	0.751	irs	1,7,18,19	36.1
11. Farabi	1.000	1.000	1.000	-	11	
12. ValiAsr	0.928	0.992	0.936	drs	2,4,6,8,13	7.2
13. RasoulAkram	1.000	1.000	1.000	-	13	
14. Motahari	0.748	0.931	0.804	irs	1,6,18,19	25.2
15. Firouz gar	1.000	1.000	1.000	-	15	
16. HashemiNezhad	0.927	0.980	0.945	irs	11	7.3
17. Shafa-Yahiaeian	0.904	1.000	0.904	irs	17	9.6
18. Iran psychology	0.919	1.000	0.919	irs	18	8.1
19. Hazrat-e Fatemeh	1.000	1.000	1.000	-	19	
Average	0.895	0.984	0.909			10.5

*irs: increasing returns to scale, drs: decreasing returns to scale, crs: constant returns to scale

ied hospitals had increasing returns to scale, about 21% of hospitals had decreasing returns to scale and 36.9% constant returns to scale.

Most of the hospitals with scale inefficiency had increasing returns to scale. Also, the findings of the study showed that the under study industry was able to achieve the same given level of production in the year of the study by 10.5% of capital and human resources reduction. Meanwhile, the studied industry was more efficient in terms of managerial efficiency and a major reason for technical inefficiency of the industry mainly returns to poor scale efficiency.

According to Table 2, in 2010, most of the studied hospitals were more efficient in terms of managerial efficiency than other types of efficiency and in some of them, managerial efficiency was lower than scale

Table 2. Results of the estimation of different types of efficiency of the studied industry in 2010

Hospital	Technical efficiency	Managerial efficiency	Scale efficiency	Kinds of returns to scale	Reference hospitals	Percent of reduction in inputs for achieving the given outputs
1. Arash	0.915	1.000	0.915	irs	1	8.5
2. Imam Khomeini	0.965	1.000	0.965	drs	2	3.5
3. Cancer Institute	0.896	0.905	0.990	drs	4,6,11,13,18	10.4
4. Baharloo	1.000	1.000	1.000	-	4	
5. Razi	0.611	0.928	0.659	irs	7	38.9
6. Roozbeh	1.000	1.000	1.000	-	6	
7. Zanan	0.990	1.000	0.990	irs	7	1
8. Sina	0.896	1.000	0.896	drs	8	10.4
9. Shariati	0.890	1.000	0.890	drs	9	11
10. Ziaeian	0.779	0.934	0.834	irs	1,7,11	22.1
11. Farabi	1.000	1.000	1.000	-	11	
12. ValiAsr	0.941	1.000	0.941	drs	12	5.9
13. RasoulAkram	1.000	1.000	1.000	-	13	
14. Motahari	0.700	0.819	0.855	irs	1,6,18,19	30
15. Firouz gar	0.918	0.940	0.976	drs	4,6,12,13	9.2
16. HashemiNezhad	0.913	0.914	0.999	drs	4,11,13,18	8.7
17. Shafa-Yahiaeian	0.762	0.882	0.865	irs	1,4,6,19	23.8
18. Iran psychology	1.000	1.000	1.000	-	18	
19. Hazrat-e Fatemeh	1.000	1.000	1.000	-	19	
Average	0.904	0.964	0.936			9.6

*irs: increasing returns to scale, drs: decreasing returns to scale, crs: constant returns to scale

efficiency. In most of the studied hospitals, technical efficiency and scale efficiency were in tandem and in the rest of the cases scale efficiency was even further. The results showed that about 31.57% of the surveyed hospitals were fully efficient in terms of technical efficiency and technical efficiency was equal to 1. In addition, approximately 63.15%of the hospitals was equal to 1 and about 31.57% of the hospitals scale efficiency was 1, in this year. The lowest level of technical and scale efficiency, respectively 0.611 and 0.659, belonged to Razi Hospital and the lowest level of with 0.819 belonged to the Motahari Hospital in the year of the study. Also, according to recent research findings about 31.57% of the studied hospitals had increasing returns to scale, approximately 36.84% decreasing returns to scale and constant returns to scale was accounted for about 32%of the hospitals.

In 2010, most of the hospitals with scale inefficiency had decreasing returns to scale. Findings showed that the studied industry could have reduced the average of 9.6% of capital and human resources to achieve the same level of production in the year of the study. Meanwhile, the studied industry was better in terms of and mainly the reason of

technical inefficiency of the entire industry, had returned to poor scale efficiency.

According to Table 3, in 2011, most of the studied hospitals were more efficient in terms of than other types of efficiency and in some of them was lower than scale efficiency. In most of the studied hospitals, technical efficiency and scale efficiency were in tandem and in the rest of the cases, scale efficiency was even further. The results of the study showed that about 15.78% of the surveyed hospitals were fully efficient in terms of technical efficiency and technical efficiency was equal to 1. The lowest level of technical efficiency of 0.517 belonged to Motahari Hospital and the lowest level of scale efficiency of 0.590 and the lowest of 0.783, respectively, belonged to the Razi Hospital and Shafa-Yahiaeian Hospital, in the year of the study. Also, according to the current research findings about 52.63% of the studied hospitals had increasing returns to scale, approximately 31.57%of the hospitals had decreasing returns to scale and constant returns to scale was accounted for about 15.8% of the hospitals. Most of the hospitals with scale inefficiency had increasing returns to scale. Findings showed that the studied industry could have reduced the average of 15.2% of

Table 3. Results of the estimation of different types of efficiency of the studied industry in 2011

Hospital	Technical efficiency	Management efficiency	Scale efficiency	Kinds of returns to scale	Reference hospital	Percent of reduction in inputs for achieving the given outputs
1. Arash	0.758	1.000	0.758	irs	1	24.2
2. Imam Khomeini	0.877	1.000	0.877	drs	2	12.3
3. Cancer Institute	0.861	0.877	0.981	irs	6,11,19	13.9
4. Baharloo	0.934	0.950	0.983	irs	6,11,19	6.6
5. Razi	0.590	1.000	0.590	irs	5	41
6. Roozbeh	1.000	1.000	1.000	-	6	
7. Zanan	0.968	1.000	0.968	irs	7	3.2
8. Sina	0.866	1.000	0.866	drs	8	13.4
9. Shariati	0.821	1.000	0.821	drs	9	17.9
10. Ziaeian	0.754	0.952	0.792	irs	1,7,19	24.6
11. Farabi	1.000	1.000	1.000	-	11	
12. ValiAsr	0.905	1.000	0.905	drs	12	9.5
13. RasoulAkram	0.887	1.000	0.887	drs	13	11.3
14. Motahari	0.517	0.848	0.610	irs	1,5,18,19	48.3
15. Firouz gar	0.900	0.848	0.900	drs	15	10
16. HashemiNezhad	0.906	0.976	0.929	irs	1,6,19	9.4
17. Shafa-Yahiaeian	0.651	0.783	0.832	irs	5,6,19	34.9
18. Iran psychology	1.000	1.000	1.000	-	18	
19. Hazrat-e Fatemeh	0.907	1.000	0.907	irs	19	9.3
Average	0.848	0.968	0.874			15.2

*irs: increasing returns to scale, drs: decreasing returns to scale, crs: constant returns to scale

Table 4. Results of the estimation of different types of efficiency of the studied industry in 2012

Hospital	Technical efficiency	Management efficiency	Scale efficiency	Kinds of returns to scale	Reference hospital	Percent of reduction in inputs for achieving the given outputs
1. Arash	0.814	1.000	0.814	irs	1	18.6
2. Imam Khomeini	0.921	1.000	0.921	drs	2	7.9
3. Cancer Institute	0.876	0.878	0.998	drs	4,12,15,16,18	12.4
4. Baharloo	1.000	1.000	1.000	-	4	
5. Razi	0.661	1.000	0.661	irs	5	33.9
6. Roozbeh	1.000	1.000	1.000	-	6	
7. Zanan	0.774	1.000	0.774	irs	7	22.6
8. Sina	0.861	1.000	0.861	drs	8	13.9
9. Shariati	0.873	1.000	0.873	drs	9	12.7
10. Ziaeian	0.809	0.963	0.840	irs	1,4,7,19	19.1
11. Farabi	1.000	1.000	1.000	-	11	
12. ValiAsr	0.998	1.000	0.998	drs	12	0.2
13. RasoulAkram	1.000	1.000	1.000	-	13	
14. Motahari	0.608	0.903	0.673	irs	5,18,19	39.2
15. Firouz gar	1.000	1.000	1.000	-	15	
16. HashemiNezhad	1.000	1.000	1.000	-	16	
17. Shafa-Yahiaeian	0.656	0.692	0.948	irs	1,16,18,19	34.4
18. Iran psychology	1.000	1.000	1.000	-	18	
19. Hazrat-e Fatemeh	0.975	1.000	0.975	irs	19	2.5
Average	0.886	0.970	0.912			11.4

*irs: increasing returns to scale, drs: decreasing returns to scale, crs: constant returns to scale

capital and human resources to achieve the same level of production in the year of the study. Meanwhile, the studied industry was better in terms of compared with scale efficiency and mainly, the technical inefficiency of the entire industry, had been affected by poor scale efficiency.

According to Table 4, in 2012, most of the studied hospitals were more efficient in terms of than other types of efficiency. Also, in some of the hospitals, and scale efficiency were in tandem and in some cases was lower than scale efficiency. In most of the studied hospitals, technical efficiency and scale efficiency were in tandem and in the rest of the cases scale efficiency was even further. The results of the study showed that about 36.84% of the surveyed hospitals were fully efficient in terms of technical efficiency and technical efficiency was equal to 1 in these hospitals. Meanwhile, in this year, in approximately 78.94% of the hospitals, was equal to 1 and in about 36.84% of the hospitals, scale efficiency was 1. The lowest level of technical efficiency of 0.608 belonged to Motahari Hospital and the lowest level of scale efficiency of 0.661 and the lowest of 0.692, respectively, belonged to the Razi Hospital

and Shafa-Yahyaeian Hospital, in the year of the study. Also, according to the current research findings about 36.84% of the studied hospitals had increasing returns to scale, approximately 26.31% of the hospitals had decreasing returns to scale and constant returns to scale was accounted for about 36.85% of the hospitals. Most of the hospitals with scale inefficiency had increasing returns to scale. Findings showed that the studied industry could have reduced the average of 11.4% of capital and human resources to achieve the same level of production in the year of the study. Meanwhile, the studied industry was better in terms of compared with scale efficiency and mainly, the technical inefficiency of the entire industry, had been affected by poor scale efficiency.

As Figure 1 and Table 5 show, has fluctuated beyond other types of efficiencies. None of the types of the efficiencies in the studied hospitals comply with specific and fixed trends and they are constantly changing. Unlike slight fluctuations, other types of efficiencies have experienced drastic undulations. However, as the chart shows, intense fluctuations of the technical efficiency returns to sharp swings in scale effi-

Table 5. Average of the efficiency indices in studied industry during 2009-2012

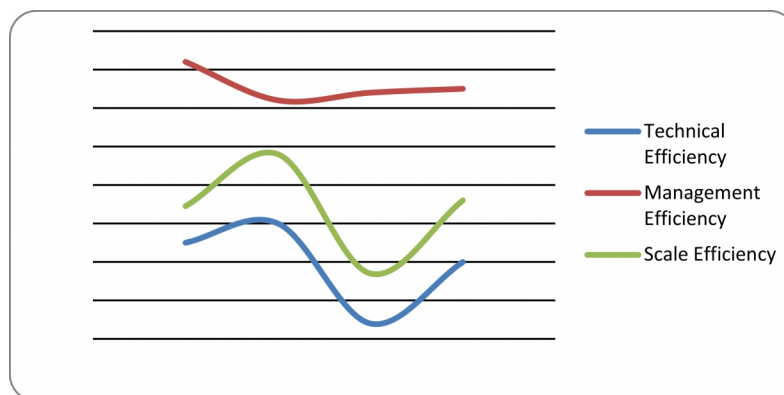| Efficiency indexes	2009	2010	2011	2012	Average of Indexes in this period
Average of Technical Efficiency	0.89	0.90	0.848	0.88	0.87
Average of Management Efficiency	0.984	0.964	0.968	0.97	0.97
Average of Scale Efficiency	0.909	0.936	0.874	0.912	0.90

Fig. 1. The trends of technical efficiency, management efficiency and scale efficiency

ciency because fluctuations in the do not seem very sensible. In the considered period, in the studied industry, the maximum amount of was obtained in 2008 and the highest levels of technical and scale efficiency was achieved in 2010.

The results of stochastic frontier analysis:
The results of the estimation of the technical efficiency showed that, all studied hospitals were technically inefficient, so that the under studied industry could have reduced 61percent of its resources to achieve the same level of outputs. In other words, by allocating 39 percent of current resource in more economic terms, the same specified level of production could be achieved. Results of this method showed that Roozbeh Hospital and Farabi Hospital, respectively have achieved the highest and the lowest technical efficiency in the studied industry. Among the studied hospitals, Technical efficiency of 26.3% of them was more than 0.5 and the rest in terms of use and allocation of human and capital resources were operating below 50% of optimized utilization of resources. Among the studied hospitals, two of them in terms of technical efficiency were operating below 0.1, considering the nature of these hospitals; this can be due to prolonged hospitalization and low positive performance indicators such as turnover ratio and bed to patient admissions during the year (Table 6).

Discussion
DEA showed that the mean value of different types of efficiency in under studied hospitals did not follow of specified and fixed trends during the time-period of project, but constantly changing. In the under studied industry, over time, the average value of management performance had been fluctuating beyond other types of efficiency. Unlike , which has gone through slight undulation, other types of efficiency have experienced extreme fluctuations. Of course as the findings present the extreme

Table 6. efficiency of the studied industry by SFA: Cobb-Douglas

Centers	Technical efficiency (2009-2012)
1. Arash	0.390
2. Imam Khomeini	0.242
3. Cancer Institute	0.320
4. Baharloo	0.621
5. Razi	0.209
6. Roozbeh	0.082
7. Zanan	0.601
8. Sina	0.386
9. Shariati	0.221
10. Ziaeian	0.573
11. Farabi	0.958
12. ValiAsr	0.393
13. RasoulAkram	0.303
14. Motahari	0.157
15. Firouz gar	0.353
16. HashemiNezhad	0.410
17. Shafa-Yahiaeian	0.293
18. Iran psychology	0.094
19. Hazrat-e Fatemeh	0.776
Mean efficiency	0.389

fluctuations in technical efficiency returns to severe falling and rising in scale efficiency, because the intensity of fluctuations in does not seem very tangible. In those hospitals that are efficient in terms of technical, management and scale efficiency, inputs have had the maximum capacity of activity. These centers have had constant returns to scale, and are placed in the horizontal section of the long-run average cost curve (LRAC) which is a curve generated to determine the optimum domain of production; and the cost of service unit is minimal in these centers.

The average of total technical, management and scale efficiency in the studied hospitals during the study period were estimated to be 0.87, 0.97 and 0.90, respectively. The under-studied industry could achieve the same specific level of output and production by 13% of reduction in its inputs during the project's period of time. In the other words, capacity promotion of efficiency is about 13%without any increase in operational costs and attraction and implementation of new institutions for mentioned centers, so that it is observed that utilization rates of inputs were inappropriate, and inputs have been involved with a form of hidden unemployment. In the hospitals which were not placed in an entirely efficient status in terms of overall efficiency during the study time, there was a significant difference between existing distribution of resources and optimized distribution of them regarding to the specified level of centers' outputs, and also, surplus resources could be seen considering certain level of production.

In this study it has been shown that surplus of human resources are more than excess capital resources means the active beds in inefficient hospitals. In Rezapour and colleagues study conducted in 2010 on the hospitals of Qazvin University of Medical Sciences, the average of total technical, management and scale efficiency in centers affiliated to the university were estimated as 0.9, 0.957, and 0.935, respectively (13). In one study done on training hospitals of

Iran university of Medical Sciences in 2005 by Kia Daliri, the average of total technical, management and scale efficiency were estimated to be 0.944 and 0.966 and 0.976, respectively (18). Another study of hospitals affiliated to Isfahan University of Medical Sciences, showed the average technical efficiency of 0.96 (19). Hatam in 2000 during a study in public hospitals of Tehran Social Security Organization suggested that 72% of hospitals in terms of the scale efficiency are faced with degrees of scale inefficiency, 39% of hospitals in terms of the technical efficiency are faced with different degrees of lack of technical efficiency and in terms of economic efficiency, 44% are faced with the degree of economic inefficiency (7). In the study of Abulhalaj et al in 2007 entitled "a measurement of technical efficiency in hospitals of the country's university health care services" the average of total technical, management and scale efficiency were respectively equal to 0.436 , 0.591 and 0.746 (20). In a study by Gannon in 2005 in order to measure technical efficiency by using DEA, it was revealed that the technical efficiency had decreased from 0.96 in 1995-1996 to 0.94 in 1999-2000 (14). Novin et al. (2004) in their study estimated the average of technical, management and scale efficiency for the under studied hospitals to be 0.474, 0.513 and 0.774 respectively; and estimated the average of technical, management and scale efficiency for medical centers as0.337, 0.574 and 0.587, respectively. They mentioned that hospitals and health centers could have reduced respectively 22.6% and 41.3percent of their inputs to produce the same current outputs (15). In the study of Puing et al (2000) titled as "a review of the economic efficiency of hospitals in Spain", economic inefficiency was calculated 24.5%. Technical inefficiency was computed 10.1%, allocation inefficiency was 12.2% , pure technical or management inefficiency was about 2.9%, condensation inefficiency was calculated 7.2%, the scale inefficiency was 4.8%, in average (16). In the study by Mortimer and Picook,

in 2002 that was conducted to measure the hospital efficiency, the economic efficiency computed 0.86 by using DEA (21). According to the WHO, more than 50% of hospital resources are not efficient enough (2). Results of the study showed that lack of economic inefficiency is clear in most of the hospitals, and they are different only in degree.

Findings of the study suggested that the studied industry faced with degrees of scale and management inefficiency during the study period, and the average of inefficiency in scale management are respectively 0.03 and 0.10. Although, the vast majority of the studied hospitals were acceptable in terms of , but they were able to provide the means of increasing efficiency to about 3% by good policy of managers and human resources' efforts. Recruitment and labor supply without systematic need assessment in centers, causes a failure to put the staff in an appropriate position in accordance with their skills and education. Lack of skilled and motivated workforce, the job training under the supervision of experts and opportunities for job rotation and job promotion are some factors that can affect efficiency of human resources (13). Sadaghiani believes that the cause of low performance indexes and consequently an increase in hospital costs is not due to lack of professionals, it is rather regarded to the lack of exploitation, conservation and proper utilization of manpower and equipments which emphasizes the importance of role of managers in this field (22).

Also, the project results showed that mentioned industry could prevent 10% of hidden unemployment of its inputs by acting in optimized scale and adjusting its activity range by considering inputs and outputs, and then reach the same previous level of output. Results suggested that most of hospitals faced with degrees of increasing returns to the scale in terms of scale inefficiency; therefore, these hospitals could have increased their activity volume by increasing inputs usage and effective use of them. Of course, those types of hospitals

that had degrees of scale inefficiency and faced with decreasing returns to scale should balance their inputs.

Scale inefficiency occurs because of some reasons such as increasing returns to scale and in some cases it happens because of decreasing returns to scale. In the first situation, venture is possible through two ways: first solution is that small hospitals which are next to each other get integrated if possible, though this can lead to decrease in access to services, this problem can be solved by bringing up health centers and equipped clinics. It should be noted that this should be done by environmental investigations and considering issues such as remoteness or proximity to other health centers. Secondly, increasing scale of production in small units gets done through implementation of additional projects to promote hospital capacity to optimized scale. This evolution should be paid attention from the aspect of expert human resources, as well as the aspect of beds and other capital resources, and also retaining their relevance together should be considered. In the case that scale inefficiency is due to decreasing returns to scale, the best solution is to adjust the extra human and capital resources; and to resolve this deficiency, revision in the general structure of hospitals is essential (19). Hence, it seems necessary that officials try to do their best to get rid of unwanted inputs and avoid the existence of capitals and human resources in non-economic areas of production and having negative final production. Incomplete utilization of hospital beds and lack of complete bed occupancy rate that are considered as positive efficiency indicators, have high influence on degrees of scale inefficiency in present study. The necessity of considering some factors like more utilization of capital resources and hospital beds, more supervision by staff of the centers in order to monitor utilization of fixed beds and elimination of its lowering obstacles can be pointed out. Sherman believes that the existence of extra beds in centers is one of the key factors affecting the effi-

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ciency loss (23) Newbrander and Kutzin stated that according to the downside process of hospital patients admissions, the hospitals should be designed in smaller sizes, and also in a study, up to the 190-bed hospital has been recommended for the developing countries (3).

According to the results of this study, it is clarified that the major reason of technical inefficiency in the studied industry is poor scale efficiency. The Study of Rezapour (2010) (13), study of Hatam (2000) (16), and Pouing and colleagues (2000) confirmed this finding. Study of Yav (2006) in local hospitals of Uganda showed that technical inefficiency in east and west areas was basically because of scale inefficiency rather than pure inefficiency, while in central areas technical inefficiency was more due to pure inefficiency rather than scale inefficiency (24). Findings of some studies (18,20,15) are not matched with present study. The underlie reason can be related to the type of studied hospitals, used models with different assumptions for estimating the efficiency, inputs combination etc.

The results of the present study by using of SFA also showed that during the study period, in approximately 26.3% of the hospitals, degree of efficiency was more than 0.5%. This method represented that over 72% of the hospitals could not utilize even 50% of their capacity. Average amount of technical efficiency in studied industry in project period was estimated 0.39 which represents that the studied industry was able to reach the same specified level of outputs by 61% reduction of inputs during research period. In other words, the capacity of efficiency promotion without any increase in operational costs and recruitment and deployment of new institutions for mentioned centers was 61%. As can be seen in studied industry, inputs utilization rate has been inappropriate and inputs are involved in a type of extreme hidden unemployment. Obtained results of this method in comparison to data envelopment analysis was significant and this factor is related to the difference in the nature of the

two approaches. In the study of Mortimer and Piecook, by measuring the efficiency of the hospitals through SFA and DEA, it has been represented that computed economic efficiency by using data envelopment analysis (0.86) is more than estimated economic efficiency (0.83). As a matter of fact, data envelopment analysis method does not show the inefficiencies well. The survey results indicate that there is no specific method which is more accurate than other approaches. In other words, each one of these methods has its own particular characteristics and can be helpful (21).

Conclusion

Efficiency and the status of human and capital resources in hospitals affiliated to Iran and Tehran universities of medical sciences, were clarified in this paper. In this study, by using DEA, amount of technical, management and scale efficiency, and also the degrees of inefficiency, excess or deficiency of inputs and the amount of optimized resources for producing the specified level of products in the inefficient hospitals were calculated, and types of returns to the expanded scale was also determined. This study presented hospitals with the highest and lowest efficiency, and introduced some patterns and references to improve the performance. According to the results, it was found that in hospitals which do not operate efficiently, capacity of increasing the technical efficiency exists through the removal of surplus factors without changes in the level of outputs. In a number of studied hospitals, health funds injection to improve performance is vital. Nevertheless, it is possible to achieve enormous economic advantages by allocation of optimized available resources in the most of under studied hospitals. Microeconomic analysis derived from health systems database can be the basis of policy making to improve the performance of healthcare organizations. All in all, results of the study showed that there are some degrees of inefficiency in the under studied industry which are compensable through improvement of

management and scale efficiency, and it is possible to achieve significant economic advantages in the future by means of improvement of the situation.

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