

The productivity and its barriers in public hospitals: case study of Iran

Bahram Nabilou¹, Hassan Yusefzadeh², Aziz Rezapour³, Farbod Ebadi Fard Azar⁴
Parviz Salem Safi⁵, Ali Sarabi Asiabar⁶, Nahal Ahmadzadeh^{*7}

Received: 27 May 2015

Accepted: 14 September 2015

Published: 6 January 2016

Abstract

Background: Due to the increasing health care costs, the issue of productivity in hospitals must be taken into great consideration in order to provide, preserve and promote public health services. Thus, increasing the level of productivity must become the main aim of any hospital. Objective of this study is to determine the total factor productivity and its components over the period under the study.

Methods: In this cross sectional study, total factor productivity changes of hospitals affiliated to Tehran University of Medical Sciences were measured according to Malmquist index over the period 2009-2014. To estimate total productivity changes using Data Envelopment Analysis method, input-oriented and variable return to scale assumptions were applied and Deap2.1 software was used.

Results: The mean value of total productivity changes was 1.013. It means that during the study period the productivity experienced a 1.3% decrease. Technological efficiency changes have the greatest influence on productivity decrease than the other factors. Scale efficiency, managerial efficiency and technical efficiency changes were ranked.

Conclusion: Lack of knowledge of hospital personnel on proper application of technology in patient treatment is the main factor leading to productivity decrease resulting from technological changes in the studied hospitals. Therefore, holding courses for personnel in order to teach them the proper use of technology in diagnosis and patient care can be helpful.

Keywords: Hospital, Productivity, Efficiency, Malmquist index.

Cite this article as: Nabilou B, Yusefzadeh H, Rezapour A, Ebadi Fard Azar F, Salem Safi P, Sarabi Asiabar A, Ahmadzadeh N. The productivity and its barriers in public hospitals: case study of Iran. *Med J Islam Repub Iran* 2016 (6 January). Vol. 30:316.

Introduction

Productivity improvement which subsequently leads to cost reduction is one of the properties of resistive economy that plays an important role in increasing the country's strength in order to move along the frontiers of development; and at the same time reducing its vulnerability against the

sanctions. The rapid development of medical science, increasing health care costs and demographic changes on one hand, and the lack of resources on the other hand, have caused some problems in the provision of medical services. Therefore, due to the increasing demand and limited resources in this sector, attention must be paid to the

¹. Associate Professor of Health Services Management, Social Determinants of Health Research Center, Urmia University of Medical Sciences, Urmia, Iran. bnabil@umsu.ac.ir

². Assistant Professor of Health Economics, Department of Public Health, School of Public Health, Urmia University of Medical Sciences, Urmia, Iran. hyusefzade2010@gmail.com

³. Assistant Professor of Health Economics, School of Health Management and Information Sciences and Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran. rezapoor_a57@yahoo.com

⁴. Professor of Health Services Management, Department of Public Health, School of Public Health, Iran University of Medical Sciences, Tehran, Iran. f-ebadi@iums.ac.ir

⁵. MSc in Health Services Management, Department of Public Health, School of Public Health, Urmia University of Medical Sciences, Urmia, Iran. p_safi2003@yahoo.com

⁶. MSc in Public Management, Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran. Sarabi.a@iums.ac.ir

⁷. **(Corresponding author)** MSc Management Systems and Efficiency, Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran. nahalahmadzadeh@yahoo.com

productivity in order to find out how one must combine factors and resources of production to provide the required services (1).

Hospital is one of the most important components of health network. The majority of the health care sector's share from the national GDP is spent in hospitals. Thus, assessing the productivity of health care services is necessary (2). By preventing or reducing waste of resources, available resources can be used to provide more services or expand access to them and improve the quality of hospital services (3).

The cost of hospital services has significantly increased in most countries during the last years so that approximately 60% of the total costs of health care sector belongs to hospitals (4). Furthermore, in most developing countries, the health sector spends 5% of GDP and 5-10% of the government's expenses. Therefore, due to the rapid increase of health care costs in relation to revenues in many of these countries, the health sector is faced with many financing problems (5).

The main stakeholders of health care are society and people that seek their benefits in more reasonable performance and further productivity of health system. The lack of efficient and effective services in health promotion reduces not only the quality of life, but also prevent from efficiency improvement in other economic sectors and causes an increase in disease, disability, physical and mental illnesses and other social, political and economic problems. For socio - economic development and reducing the current problems, there is no choice except to improve productivity (6).

Utilization of resources for effective preparation and provision of health care services require awareness and use of economic tools. The process in which productivity rate is investigated and evaluated and the results are subsequently compared with specific criteria is considered as one of the common tools in the study of health care system performance (7). Carrying out such studies paves the way for the use of these tools in health care management and plan-

ning, on one hand, and optimized resource allocation, on the other hand. Therefore, these criteria can be used as a control tool and measures can be taken to modify them (8).

In cases where productivity is not measured, decision making becomes very difficult for policy makers and planners and the majorities of decisions that are made are unscientific and impractical and result in the waste of valuable resources in the health care sector (9). Obviously, determining the productivity of hospitals in production, allocation and use of resources in health care according to Malmquist index is one of the fundamental steps in this regard.

Given the importance of the subject, Data Envelopment Analysis (DEA) method has been used to measure the productivity of hospitals. This method is based on a series of optimizations using linear programming. In this method, each hospital's productivity can be individually calculated using Malmquist index. Moreover, changes in productivity can be divided into two categories: efficiency-related and technological changes (10).

It is expected that health system managers and planners be familiar with the productivity trend and the factors affecting it and accordingly, take the necessary steps in order to reach optimized resource allocation and improved productivity. By removing barriers that impede productivity improvement, productivity of health care centers can be enhanced without changing production inputs. The results of this study can also help health care sector's policy makers and managers in making rational decisions.

This paper seeks to answer the following questions: what is productivity trends of hospitals affiliated to Tehran University of Medical Sciences? Which factors have the most influence on the changes in overall productivity?

Methods

The study population consisted of all the hospitals affiliated to Tehran University of Medical Sciences. The data were collected

over the period between 2009 and 2014. As the total research population was used in the study, there was no need for sampling. Due to the lack of full access to information in some hospitals, the study was limited to these hospitals. The number of hospitals affiliated to Tehran University of Medical Sciences was 17. In order to comply with ethical considerations, the results of each hospital are displayed using its own corresponding number.

Regarding to the previous research, a combination of most important and common inputs and outputs were used to estimate the total factor productivity changes. The required data and information (including outpatient admission, occupied bed days, number of surgical operations, active beds, nurses, doctors and other personnel) were collected from the investigated hospitals and treatment deputy of Tehran University of Medical Sciences via checklists developed by the researchers.

In general, the concept of productivity is the ratio of outputs produced by the system providing services and products to the inputs used in such process. Also, productivity can be defined as the ratio of the results of a work to the work completion time. A higher productivity means producing or completing more products using the same amount of resources or obtaining more and higher-quality outputs using the same amount of inputs (7,11). Partial productivity is the ratio of outputs to a group of inputs, while total productivity is the ratio of output to the sum of the total inputs. Therefore, total productivity shows the joint effect of all inputs in the production (12).

Data Analysis

After collecting the required data from the hospitals affiliated with Tehran University of Medical Sciences, DEA method was used to evaluate the changes of total productivity based on Malmquist index.

In this research, DEA technique and Malmquist index are used to measure and analyze five factors including total technical efficiency changes, technological ef-

iciency changes, managerial efficiency changes (or pure technical efficiency), scale efficiency changes and total factor productivity changes (ΔTFP) for each individual hospital. Using distance functions, Malmquist productivity index is defined as follows:

$$M_i^{t+1}(q^{t+1}, X^{t+1}, q^t, X^t) =$$

$$\frac{D_i^t(q^{t+1}, x^{t+1})}{D_i^t(q^t, x^t)} \left[\frac{D_i^t(q^{t+1}, x^{t+1})}{D_i^{t+1}(q^{t+1}, x^{t+1})} \cdot \frac{D_i^t(q^t, x^t)}{D_i^{t+1}(q^t, x^t)} \right]^{1/2} = E_i^{t+1} \times T_i^{t+1}$$

Total factor productivity index (M_i^{t+1}) is equal to the product obtained by multiplying technological changes (T_i^{t+1}) calculated through transfer of frontier production function between periods t and t+1 by efficiency changes (E_i^{t+1}) in the same period. Distance function (D_i) indicates the relative distance of each hospital from the efficient frontier. In other words, such distance describes the efficiency and productivity level of hospitals. (q^{t+1}, X^{t+1}) and (q^t, X^t) are the output and input values in period t+1 and t, respectively (10,13). Finally, the calculated indexes for each of the hospitals are as follows:

Total productivity changes = Managerial efficiency changes \times Scale efficiency changes \times Technological changes

On one hand, technological changes represent the impact of technology on output and only cause the production function to shift. On the other hand, they show the interactions between factors and the impact they had on production factors over time. Did they cause replacement of factors or did they save in use of factors and subsequently change their efficiency level? Technical efficiency deals with the ways by which hospitals increase their output without increasing production inputs.

Pure technical efficiency or managerial

efficiency indicates that managers' hard work, effort and scheme of management, personnel's efforts and the correct combination of production factors have led to increased productivity in hospitals. Scale efficiency is the ability of a hospital to avoid wasting resources by acting under circumstances that are in conformity with the most profitable scale or at least similar circumstances (14,15).

If Malmquist index, on the basis of minimization of production factors, is less than 1, it implies improvement of performance; however, if Malmquist index is greater than 1, it suggests the performance deterioration over time. In this stage, the type of returns to scale of hospitals is also identified.

In the next stage, challenges and strategies to improve productivity in the hospitals affiliated to Tehran University of Medical Sciences are investigated. Challenges refer to the main barriers to productivity improvement in the hospitals being studied. Productivity improvement strategies in the mentioned hospitals apply to all considerations can have a significant positive impact on productivity improvement. To examine the challenges of productivity improvement and the strategies that deal with such challenges, opinions and experience of hospital managers and health care experts have been utilized. This section of the research is of a qualitative nature.

Input minimization and variable return to scale assumptions are used to calculate total factor productivity changes (Malmquist productivity index). Deap2.1 software was used to estimate the value.

Results

The results obtained through calculation of total factor productivity based on Malmquist index and analysis of its changes regarding the influencing factors are given in the Tables 1 and 2. In this study, 2009 was considered as the basic year for assessment of other years.

Total productivity changes are the result of changes in scale, managerial and technological efficiencies. According to Table 1,

during the period under review, the mean value of total productivity changes is equal to 1.013. As the calculated value is greater than one, productivity has deteriorated during the study period. More specifically, productivity has experienced a deterioration of 1.3%. Also, the mean value of changes in technical, technological, scale and managerial efficiency were 0.992, 1.024, 0.999 and 0.994, respectively.

According to the above table, the worst and the best performance in terms of productivity belongs to hospitals 9 (1.201) and 6 (0.935), respectively.

After examining the results of Malmquist index regarding total productivity changes and its components (Tables 1 and 2), the following points were made:

1. Based on the results obtained via Malmquist index, the mean of hospitals' output change due to technological changes during the period under review was 1.024. In other words, in this period, technological changes have averagely led to 2.4% annual decrease in the output of the hospitals under study.

2. The average value of technical efficiency of the studied hospitals between the years 2009 and 2014 is equal to 0.992; it means that hospitals can averagely increase their outputs 0.8% without increasing the amount of inputs.

3. The average managerial efficiency value of the studied hospitals is 0.994. This means that without increasing inputs and only by better management and personnel effort, hospitals can increase their productivity up to 0.6%.

4. The average scale efficiency of the studied hospitals is 0.999. Therefore, hospitals with decreasing returns to scale conditions should reduce their input values because if we assume that output level is fixed and stable, the input increase ratio will be greater than the output increase ratio. As a result, long run marginal cost (LRMC) and subsequently long run total cost (LRTC) will be increased. Hence, decrease in input value will be economically justified.

Table 1. Total productivity Changes and its components in all studied hospitals during the years 2009-2014 using DEA method

Year	Technical efficiency (effch)	Technological efficiency (techch)	Managerial efficiency (pech)	Scale efficiency (sech)	Total Factor Productivity Changes (tfpch)
2010	0.905	1.138	0.981	0.922	1.029
2011	1.003	0.999	0.993	1.011	1.003
2012	1.062	0.945	1.015	1.046	1.003
2013	1.005	0.977	0.985	1.021	0.983
2014	0.986	1.060	0.994	0.993	1.046
Mean	0.992	1.024	0.994	0.999	1.013

Table 2. Total factor productivity changes and its components in each of the hospitals over the study period (DEA method)

Hospital	Technical efficiency (effch)	Technological efficiency (techch)	Managerial efficiency (pech)	Scale efficiency (sech)	Total Factor Productivity Changes (tfpch)
1	0.979	0.991	1.000	0.979	0.970
2	0.985	1.021	0.977	1.008	1.005
3	1.000	1.069	1.000	1.000	1.069
4	1.000	1.026	1.000	1.000	1.023
5	0.946	1.008	0.997	0.949	0.954
6	1.000	0.935	1.000	1.000	0.935
7	1.000	1.025	1.000	1.000	1.025
8	0.982	1.035	0.977	1.005	1.018
9	1.000	1.201	1.000	1.000	1.201
10	1.000	0.986	1.000	1.000	0.986
11	0.962	1.036	1.000	0.962	0.997
12	0.989	1.010	0.984	1.006	1.000
13	1.011	0.986	1.000	1.011	0.997
14	0.997	1.005	0.979	0.998	0.982
15	1.000	1.026	1.000	1.000	1.024
16	1.016	1.010	1.000	1.016	1.026
17	1.023	0.996	1.002	1.021	1.019
Mean	0.992	1.024	0.994	0.999	1.013

The analysis of Malmquist productivity index changes based on separate influencing factors indicates that during the period under review, technical efficiency changes and technological changes have averagely the most and least positive impact on the productivity, respectively.

Discussion

In evaluating the activities and performance of the hospitals, the main motivating factor that encourages the use of scientific and applicable methods is efficient use of physical, technological and available human resources. In addition to helping the better resource management and cost reduction, this study can be used as a tool for policy-making. This evaluation of hospital performance allows hospitals to identify the amount of their optimal and potential use of resources, compare their performance with that of successful hospitals and determine their enhancement capacity.

The mean value of total factor productivity changes based on the findings of the DEA method in the period under review was equal to 1.013. This represents a 1.3% decrease in total factor productivity in the studied hospitals during the period; with technological efficiency having the greatest impact on productivity decrease compared to other factors. Scale, managerial and technical efficiencies were ranked next.

The majority of foreign research conducted in developing countries such as studies by Kirigia et al. in Angola's hospitals, Yawe et al. in Uganda's hospitals, and etc., consider technological changes as the main reason for the decrease in total factor productivity over the period. These findings confirm the results of the present study. In conclusion, the studied research hospitals didn't appropriately benefit from the technological advances in medical sciences (16-17). Najafi et al. have obtained similar results in Ardabil's hospitals between the

years 2000 and 2006. In their study, the average TFP was 1.033, indicating a 3.3% decrease in productivity over this period. The mean value of technical and technological efficiency changes were 1.004 and 1.029, respectively. Productivity changes didn't follow a specific trend over the study period. The trend was of an ascending nature during the first three years (decreased productivity). Then, productivity improved during the next two years. Again, the hospitals dealt with productivity decrease in 2006. In total, total factor productivity decreased potentially due to technological changes (18).

Insufficient knowledge of hospital personnel on proper use of technology in the treatment of patients can be the cause of this issue. So, in hospitals where the main reason for decreased productivity is technological changes, it is necessary to offer training courses for personnel on proper use of technology in the diagnosis and care of patients. In this study, Hospitals' output experienced an annual increase of 2.4% on average as a result of technological changes, without producing any change in the value of production factors.

Hospitals with increasing return to scale should increase their level of service provision because under such circumstances, an increase in service delivery has economic justification. Hospitals with a technical efficiency score of less than 1 can increase their output without increasing values of production inputs as a result of efficient use of resources. Obviously, good management and staff motivation can improve productivity without changing input values. Therefore, modifying manager and employee relationships, correcting leadership, marking personnel's comments and suggestions, promoting and encouraging innovation and creating a favorable working environment are factors that can be effective in improving productivity in hospitals.

Despite the importance of adherence to the principle of productivity in hospitals where costs of providing health care services show an ever growing trend, some

factors hinder productivity improvement and produce many obstacles for the proper administration of hospitals. Necessity to recognize these barriers, plan on removing them and prepare the required context for productivity improvement is of utmost importance.

According to the results of literature review and official reports and interviews, the most important barriers to productivity improvement in the studied hospitals are as follows: methods used for management and organization of hospitals, lack of proper implementation of the new system of administration in hospitals, instability in implementing control programs or absence of efficient and effective supervisory systems, dominance of bureaucracy in hospitals, discrimination between personnel, inefficient use of limited resources, unnecessary prescription of diagnostic and therapeutic services, personnel's lack of interest in work, consecutive turnover of staff, lack of investment in human resources, outdated tariffs of diagnostic and therapeutic services considering medical advancements and prevalence of bribery, unfair and inadequate payments, ignoring the cultural environment of hospitals, and etc. (19-23).

To evaluate other aspects of this issue, calculating productivity, profits and losses in hospitals using production and cost functions and also investigating hospitals' economic efficiency through economic methods are recommended.

One of the limitations of this research was the lack of access to statistics of some of the hospitals' variables (inputs or outputs) during the study period. As a result, these hospitals were excluded from the study.

Conclusion

Reforming the dominant system in hospitals in order to reduce bureaucracy and establish an appropriate structure, designing proper regulatory mechanisms as criteria for measuring progress of hospitals toward achieving their goals, determining actual tariff of health care services and updating them according to medical advances; prop-

er implementation of the new system of administration of hospitals; establishing appropriate performance-based payment system and reward and punishment system for employees, use of appropriate management practices in accordance with the requirements, holding training courses for personnel, changing working conditions and personnel motivation methods, improving systems, laws and regulations, circulars, instructions, methods, technologies, and etc. are considered as strategies for productivity improvement in hospitals under investigation.

Acknowledgments

We would like to thank the management and personnel of hospitals affiliated to Tehran University of Medical Sciences for their cooperation. Also, it is necessary to thank the school of health, Urmia University of medical sciences for helping in electronic sources. The authors declare that there is no conflict of interest.

References

1. Pourreza A, Goudarzi G, Azadi H. Determination of technical efficiency of hospitals affiliated with Tehran University of Medical Science by the data envelopment analysis method: 1996-2006. *Journal of School of Public Health and Institute of Public Health Research* 2010;7(4):79-86.
2. Nghiem S, Coelli T, Barber S. Sources of productivity growth in health services: a case study of Queensland public hospitals. *Economic Analysis and Policy* 2011;41(1):37-48.
3. Rebba V, Rizzi D. Measuring Hospital Efficiency through Data Envelopment Analysis when Policy-Makers' Preferences Matter: An Application to a Sample of Italian NHS Hospitals. University Ca'Foscari of Venice, Dept of Economics Research Paper Series 2006;(13/06).
4. Yusefzadeh H, Ghaderi H, Bagherzade R, Barouni M. The Efficiency and Budgeting of Public Hospitals: Case Study of Iran. *Iranian Red Crescent Medical Journal* 2013;15(5):393.
5. Giokas D. The use of goal programming, regression analysis and data envelopment analysis for estimating efficient marginal costs of hospital services. *Journal of Multi-Criteria Decision Analysis* 2002;11(4-5):261-8.
6. Maleki M, Mosazadeh M, Ahmadi M. The Related Factors on Productivity in Selected Medical University of Mazandaran Hospitals. *Journal of Health Administration* 2005;8(21):82-7.
7. Bloom N, Van Reenen J. Human resource management and productivity. *Handbook of labor economics* 2011;4:1697-767.
8. Chandra A, Cutler DM, Huckman RS, Martinez E. *Hospital Organization and Productivity*. NBER Books 2014.
9. Kengil B, Gökmen N, Tozan H. Efficiency measures in the health services with DEA-An overview. *Journal of Naval Science and Engineering* 2010;6(1):1-14.
10. Akazili J, Adjuik M, Jehu-Appiah C, Zere E. Using data envelopment analysis to measure the extent of technical efficiency of public health centres in Ghana. *BMC international health and human rights* 2008;8(1):11.
11. Hollingsworth B. The measurement of efficiency and productivity of health care delivery. *Health economics* 2008;17(10):1107-28.
12. Chang SJ, Hsiao HC, Huang LH, Chang H. Taiwan quality indicator project and hospital productivity growth. *Omega* 2011;39(1):14-22.
13. Cooper WW, Seiford LM, Tone K. *Data envelopment analysis: a comprehensive text with models, applications, references and DEA-solver software*: Springer Science & Business Media; 2007.
14. Kirigia JM, Emrouznejad A, Cassoma B, Asbu EZ, Barry S. A Performance Assessment Method for Hospitals: The Case of Efficiency of Health System Units in Africa: A Data Envelopment Analysis. 2015.
15. O'Donnell C. Econometric estimation of distance functions and associated measures of productivity and efficiency change. *Journal of Productivity Analysis* 2014;41(2):187-200.
16. Kirigia JM, Emrouznejad A, Cassoma B, Asbu EZ, Barry S. A performance assessment method for hospitals: the case of municipal hospitals in Angola. *Journal of Medical Systems* 2008;32(6):509-19.
17. Yawe BL. Total Factor Productivity Growth in Uganda's District Referral Hospitals. *Tanzanian Economic Trends, TET: A Biannual Review of the Economy* 2006;19(2):26-42.
18. Najafi B, Beheshti Dehkordi A, Emami Meibodi A. The productivity of general hospitals of Ardebil Province (1999-2006). *The Journal of Qazvin University of Medical Sciences* 2011; 14(4):64-70.
19. Ammons DN. Productivity barriers in the public sector. *Public Administration And Public Policy-New York* 2004;107:139-64.
20. Lachman P, Runnacles J, Dudley J. Equipped: overcoming barriers to change to improve quality of care (theories of change). *Archives of disease in childhood-Education & practice edition* 2015; 100(1):13-8.
21. Lenneman J, Schwartz S, Giuseffi DL, Wang C. Productivity and health: an application of three

perspectives to measuring productivity. *Journal of Occupational and Environmental Medicine* 2011; 53(1):55-61.

22. Rezapoor A, Roumiani Y, Azar F, Ghazanfari S, Mirzaei S, Asiabar A, et al. Effective factors on utilization and access to health care: a population-

based study in Kerman. *Journal of Health Administration (JHA)* 2015;18: Pe24-Pe35, En36.

23. Sarabi A. Active Leadership Can Promote Leadership Effectiveness in Healthcare Organizations. *International Journal of Hospital Research* 2015;4:0-0.