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M. ŞAHİN GÖK

DISSERTATION

DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF BUSINESS ADMINISTRATION

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DOKTORA TEZİ JÜRİ ONAY SAYFASI

G.Y T.E. Sosyal Bilimler Enstitüsü Yönetim Kurulu'nun 24.01.2012 tarih ve 2012/03 sayılı kararıyla oluşturulan jüri tarafından 13/02/2012 tarihinde tez savunma sınavı yapılan Mehmet Şahin Gök'ün tez çalışması İşletme Anabilim Dalında DOKTORA tezi olarak kabul edilmiştir.

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SUMMARY

TITLE OF DISSERTATION: EFFICIENCY EVALUATION OF TURKISH HOSPITALS BY USING DATA ENVELOPMENT ANALYSIS

AUTHOR NAME: M. ŞAHİN GÖK

The aim of this study is to investigate the efficiencies and inefficiency causes of hospitals in Turkey with respect to their ownerships for the study years from 2001 to 2008. Hospital ownership in Turkey can be broadly classified into three major groups such as (i) functional ownership, (iii) teaching mission ownership and (i) profit seeking ownership. The impact of health care reforms such as Performance-Based Payment System on the hospital efficiencies is also examined in order to highlight possible policy implications for policy makers.

This study is mainly composed of four sections. In the first section, efficiencies of Turkish hospitals are analyzed with respect to their functional ownerships (public, education & research, university and private hospitals). This section mainly investigates whether hospital efficiencies differ with respect to their ownership. In the second section, capacity-based inefficiency causes and the existence of any differences between the improvement processes of teaching and non-teaching hospitals are analyzed. In the third section, controversial relationships between hospital efficiency, service quality and patient satisfaction are analyzed. Final section examines the relationship between hospital efficiency and health expenditures, and addresses the impact of Performance-Based Payment System on the efficiencies of public and private hospitals.

In an effort to comparatively evaluate the hospital efficiencies, this study uses Data Envelopment Analysis. In addition Malmquist Productivity Index (MPI) is used to analyze the patterns of efficiency change for the study years. Several improvement suggestions have been provided to the health care policy makers regarding the inefficiency causes and the ways to optimize hospital efficiency.

ÖZET

TEZİN BAŞLIĞI: VERİ ZARFLAMA ANALİZİ İLE TÜRKİYE HASTANELERİNİN VERİMLİLİK DEĞERLENDİRMESİ

YAZAR ADI: M. ŞAHİN GÖK

Bu çalışmanın amacı Türkiye hastanelerinin verimliliklerini ve verimsizlik sebeplerini 2001 ve 2008 yılları arasında incelemektir. Türkiye'de hastaneler sahipliklerine göre üç ana gruba ayrılmaktadırlar. Bu sahiplik türleri: (i) fonksiyonel sahiplik,(ii) eğitim misyonu sahipliği ve (iii) kar amacına dayalı sahiplik. Sağlık politikalarına yönelik muhtemel uygulamaları değerlendirmek için Performansa Dayalı Ücretlendirme gibi sağlık reformlarının hastane verimliliği üzerindeki etkileri de çalışma kapsamında ayrıca incelenmektedir.

Bu çalışma temel olarak dört ana bölümden oluşmaktadır. Birinci bölümde Türkiye hastanelerinin fonksiyonel sahipliğine (devlet, eğitim & araştırma, üniversite ve özel hastaneler) bağlı olarak verimlilikleri analiz edilmektedir. Bu bölümde hastane verimliliğinin sahiplik türüne bağlı olarak değişip değişmediği incelenmektedir. İkinci bölümde, eğitim ve eğitime yönelik olmayan hastanelerin kapasiteye bağlı verimsizlik sebepleri ve bu hastaneler arasında iyileştirme süreçlerinde farklılık olup olmadığı değerlendirilmektedir. Üçüncü bölümde hastane verimliliği, hizmet kalitesi ve hasta memnuniyeti arasındaki ilişki analiz edilmektedir. Son bölümde ise hastane verimliliği ve sağlık harcamaları arasındaki ilişki, Performansa Dayalı Ücretlendirme Sistemi'nin kamu ve özel hastanelerin verimliliğine olan etkisi perspektifinde değerlendirilmektedir.

Hastane verimliliklerin karsılaştırmalı olarak analiz edilmesi amacıyla Veri Zarflama Analizi kullanılmıştır. Buna ek olarak hastane verimliliklerinin yıllar içerisindeki değişim trendinin analizinde Malmquist Productivity Index kullanılmıştır. Bu çalışma sonucunda, hastane verimliliklerinin iyileştirilmesine ve verimsizlik sebeplerinin ortadan kaldırılmasına yönelik olarak sağlık politikası uygulayıcılarına çeşitli öneriler getirilmektedir.

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I would like to gratefully thank my mom and dad and my whole family who has a profound influence on my life. They gave me the incentive and motivation to achieve my goals. Their unconditional support has always encouraged me in my academic career. I am also thankful to all my friends who have shared my years of graduate studies at Gebze Institute of Technology, I will never forget them.

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It is pleasure to indicate that this dissertation is dedicated to my wife, my daughter and my family.

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LIST OF ABBREVIATIONS

TMoH	: Turkish Ministry of Health
PBP	: Performance-Based Payment
DEA	: Data Envelopment Analysis
DMU	: Decision Making Unit
CRS	: Constant Return to Scale
VRS	: Variable Return to Scale
IRS	: Increase Return to Scale
DRS	: Decrease Return to Scale
MPI	: Malmquist Productivity Index
MPSS	: Most Productive Scale Size
SFA	: Stochastic Frontier Analysis
LSR	: Least Square Regression
EC	: Efficiency Change
TC	: Technology Change
TE	: Technical Efficiency
PTE	: Pure Technical Efficiency
SE	: Scale Efficiency
TQM	: Total Quality Management
VIF	: Variance Inflation Factor
BUR	: Bed Utilization Rate
BTR	: Bed Turnover Rate
TSO	: Total Surgical operations
NOB	: Number of Births
TOV	: Total Outpatient Visits
AFID	: Average Facility Inpatient Days
NOD	: Number of Discharge
THB	: Total Number of Hospital Beds
NOSP	: Number of Specialist Physicians
NONSP	: Number of Non-Specialist Physicians

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1. INTRODUCTION

In today's dynamic and rapidly changing socio-economic conditions, all institutions have to search and find ways for continuous improvement. As a service business, health care institutions have followed the similar pattern to achieve performance improvements. Therefore, efficiency has been one of the most important criteria for hospitals using limited resources for maximum value.

Given the complexity in both the nature and the environment of health care, managers should analyze, design, and implement improvement processes to achieve efficiency. Improving health services is a perennial problem for policy makers and governments in developing countries (Ozgulbas and Koyuncugil, 2009). In addition, governments in most developing countries are faced with the complication of ever increasing health care costs. As Watcharasriroj and Tang (2004) concluded, the increasing trend in health care cost has forced governments to focus on the assessment and improvement of hospital efficiency, considering the need to assure the best utilization of scarce resources (Lee et al., 2009).

Therefore, the growing trends of health care expenditures have forced the governments and health care policy makers to be more concerned with health care productivity, efficiency and inefficiency causes. Although health care providers inevitably focus on these issues, an inefficient utilization of health care resources still remain the main reason for increased spending on health care services.

The paucity of health care resources is especially troubled in developing countries where poor health condition is one of the most important complications for economic development and welfare (Chang et al., 2010). Health related costs in developing economies have been growing considerably in recent years and inefficiency has contributed to these rising costs (Weng et al., 2009). Recent research indicates that maximizing efficiency and service quality in hospitals has become an increasingly essential dynamic for hospital administrators (Valdmanis et al., 2008).

Therefore, health care institutions are required to be more efficient while providing high quality of care (Garcia-Lacalle and Martin, 2010). Health care reforms are implemented to effective utilization of scarce resources for maximization of efficiency in pursuit of better health care quality. Hence, hospitals have to improve their quality and efficiency in pursuit of better patient satisfaction.

One of the other underlying goals of the health care reforms is to decrease the health care expenditures, especially for developing countries. These reforms include managerial decentralization, the use of performance-based contribution payment system, and the implementation of policies that allow patients to choose their hospitals (Allen, 2009; Botten et al., 2004). These policy changes have critically affected the health care industry and have forced hospitals to operate in a more efficient manner (Lee et al., 2009).

Since the efficient utilization of health care resources are significant prerequisite for cost and quality control, the concepts of efficiency and productivity completely essential for performance improvement of health care systems (Dimas et al., 2010). Dimas et al. (2010) also state that the level of health care productivity is a significant indicator for the economic growth and social development and also relates the health expenditures with the improvement of the quality of life and economic progression. Therefore, the comparison of the trends of hospital efficiency and health expenditures provides the insights about the improvement of national health care system. Especially, the success of health care reforms such as Performance-Based Payment System (PBP) system in Turkish hospitals could be better assessed by evaluating the relation between efficiency and health care expenditures for the former and the latter period of the PBP system implementation.

Performance-Based Payment System has been implemented across Turkey since 2004. Turkish Ministry of Health refers the PBP system as not only a monetary payment model, but also as an application which rewards the staff based on a "success criteria". PBP system, as being a dynamic application, has been continuously developed since the date on which it was launched and renewed depending on the strategic targets of the Turkish Ministry of Health (TMoH) (Aydın and Demirel, 2007).

Hospital productivity and financial management of national health care system become increasingly crucial for health care providers according to the changes in medical environment on national health system by implementing PBP system. As Lee et al. (2009) indicate that the properly measurement of hospital efficiency is essential for evaluating the impact of policies on the health care industry. This study also examines whether PBP system has a positive influence on the hospital efficiency.

Accordingly, one of the principal objectives of the current study is to examine whether ownership-based hospital efficiency is related with health care expenditures by employing the hospital data from 2001 to 2008 in Turkey. In this context, this study also seeks (i) to identify inefficiency causes of hospitals, (ii) to examine the productivity changes of hospitals due to the implementation of PBP system and (iii) to provide some useful suggestions to achieve efficiency improvement for hospitals.

Although efficiency cannot be considered as the only final outcome of a health care organization, improvements in this aspect can provide enhancements in other institutional goals (Prior, 2006) such as service quality and patient satisfaction. Indeed, examining purely efficiencies of hospitals is just a part of the puzzle of assessing health services. A more appropriate evaluation should include the service quality and patient satisfaction perspective. In an effort to assess this controversial relationship, this study aims to contribute to the existing literature by investigating the relationships between hospital efficiency and service quality as well as their impact on patient satisfaction.

Since Nunamaker (1983) published the first health care efficiency analysis comparing small hospitals in Wisconsin, utilization of efficiency analyses in health care has become widespread. In spite of its acknowledged relevance, interestingly, there is a lack of empirical studies which evaluate the inefficiency causes hospitals. We aim to contribute to the previous works by analyzing the inefficiency causes of hospitals according to the three main ownership classifications such as (i) profit seeking ownership, (ii) functional ownership and (iii) teaching mission ownership by using Data Envelopment Analysis (DEA).

This paper contributes to the existing literature in various ways. First, while earlier researches used DEA to examine hospital efficiency, none of them has analyzed the inefficiency causes in terms of the capacity and the utilization of capacity. Second, by analyzing the efficiencies of hospitals in Turkey, which is a developing country, we provide evidences on the inefficiency causes using data outside the US and other developed countries. Hence, as Chang et al. (2004) argued, given the rareness of research using international data this study provides valuable evidence in an international context especially for developing countries. Third, results have policy implications that can help for the improvement of hospital efficiencies. Thus, hospital executives, health care policy makers, and other stakeholders may benefit from this study in order to make better decisions regarding capacity allocations and improve health care production performance.

The results of this exploratory study have also provided meaningful insights into Turkish health care policy makers' views of the interaction between efficiency and health care expenditures and the implementation success of PBP system. It is expected that the findings will provide guidance for health care providers in Turkey. Results also might be beneficial for other developing countries.

1.1. Research Questions

The research questions that this study attempts to address are presented in the below.

1. Do hospital efficiencies differ with respect to their ownership?
2. What are the main inefficiency causes of hospitals?
3. Do hospital efficiencies change according to the Performance-Based Payment System?
4. What kind of controversial relationship can be defined between hospital efficiency and service quality?
5. Is there any direct and/or indirect impact of hospital efficiency on patient satisfaction?
6. What is the linkage between hospital efficiency and health expenditures?

2. EVALUATION OF EFFICIENCY

2.1. Efficiency

Efficiency is commonly defined as the ratio of outputs to inputs and is consequently focused on the productivity of production. Although the terms *efficiency* and *productivity* can be used interchangeably, there is a few caveats with respect to use of these terms. Any unit either on the production frontier which is used to define the relationship between inputs and outputs, is efficient. If this unit beneath the frontier it is not efficient (*inefficient*). Nonetheless any unit may be efficient but may still be able to improve its productivity by exploiting scale economies. Therefore, efficiency and productivity can be given short-term and long-term interpretations in some cases (Coelli et al., 2005). In addition to this diversity, efficiency can be used more “loaded” term and it may be used as a value judgment. On the other hand, productivity is somewhat less sensitive, and it has less used as a value judgment. Efficiency can be defined with the following components (Sherman and Zhu, 2006):

Allocative Efficiency: It refers the use of the optimal mix of inputs to produce the products or services. This also relates to the question of whether the mix of capital is optimal. Allocative efficiency measures the ability of the unit to use inputs in optimal proportions given their prices.

Price Efficiency: It assesses the balance between the input prices and the quality standards (expectation from these inputs). If inputs (human capital and/or material etc.) are bought at a lower price without sacrificing quality, price efficiency could be increased. Price efficiency can be examined by using price or cost information for inputs and/or outputs.

Technical Efficiency: This is the most common used efficiency term that examines the amount of produced outputs with using the amount of inputs. Technical efficiency measures the ability of the unit to obtain the maximum output from given inputs.

Scale Efficiency: It addresses the optimal activity volume level. According to this efficiency component, producing more or less outputs than the optimal level might be results of the non-optimal volume or size.

2.2. Efficiency Analysis

Efficiency analysis is concerned with the measuring the efficiency-performance which convert inputs into outputs. Efficiency-performance can be defined in many aspects. A basic measure of efficiency-performance is the productivity ratio. It addresses the ratio of outputs to inputs where larger values are associated with the better efficiency-performance. Efficiency can be defined as the ratio of output per unit to per unit of input.

$$Efficiency = \frac{\text{Output}}{\text{Input}}$$

As Ozcan (2008) noted, there is four options to improve efficiency as follows:

- Increase the outputs
- Decrease the inputs
- If both outputs and inputs increase, the rate of increase for outputs should be greater than the rate of increase for inputs

- If both outputs and inputs decrease, the rate of decrease for outputs should be lower than the rate of decrease for inputs

Efficiency is a relative concept and has a comprehensive structure. The general use and the relative specifications of some efficiency measurement methods, excluding Data Envelopment Analysis (DEA), are discussed in this section. Detailed discussion about DEA that used to analyze the relative efficiencies of Turkish hospitals in the current study can be found in the Chapter 5. These methods differ regarding the type of measures, the required data, and the assumptions of the structure of the production technology. Some methods only require data on quantities of inputs and outputs while others also requires price data and various assumptions, such as cost minimizations, profit maximization, functionality between inputs and outputs, etc. (Coelli et al., 2005).

2.2.1. Ratio Analysis

Efficiency measurement naturally based on the concept of a ratio of outputs to inputs. Ratio analysis is the simplest methods of efficiency-performance measurement. It produces information on the relationship between single input and single output.

Often many different ratios are used to focus on different aspects of performance. Ratios are generally calculated to compare various dimensions of performance among comparable units and within the single unit over time period. On the other hand, using multiple ratios often produces mixed results that confuse the comparative efficiency-performance analysis.

Several limitations of ratios are existent when a set of ratios is used. It is difficult to interpret the complexity of a set of ratios aimed to evaluate the efficiency. Since the ratios represent a range of actual results, there is no objective point above or below which define the unit as an efficient or inefficient.

Despite some limitations, ratios are usefulness in many instances. Ratio analyses also provide actionable insight, especially use in tandem with other techniques, which can be afforded to improve efficiency.

2.2.2. Stochastic Frontier Analysis

Stochastic Frontier Analysis (SFA) is an alternative approach to the estimation of efficiency frontier functions using economic techniques. SFA is a parametric technique. In contrary to Least Square Regression (LSR), it assumes that all the units are not efficient and accounts for noise.

Stochastic Frontier Analysis can be used to measure technical efficiency, scale economies, allocative efficiencies, technical change and total factor productivity as well as it can be used to conduct tests of hypothesis. SFA requires input and output quantities for empirical estimation of production function (Ozcan, 2008).

There are a number of considerations when estimating efficiency by using Stochastic Frontier Analysis (Jacops et al, 2006). These are presented in the below:

- Whether to estimate a production or a cost function
- Whether to transform variables
- Whether to estimate a total or an average function
- Which explanatory variables to include
- How to model the residual
- How to extract the efficiency estimates

Stochastic Frontier Analysis based on the economic theory when considering the shape of the frontier and statistical criteria might be used to discriminate the suitability of alternative functional relationship for particular data set. SFA models are formulated principally to extract individual analysis of efficiency from the unexplained part of the model. Nevertheless, SFA needs to the full sample data when estimating relative efficiency. In addition to making greater use of the available data, SFA can calculate individual efficiencies more robust to the presence of outliner observations and a typical input/output combination (Jacops et al., 2006).

Stochastic frontier approach, as a parametric technique, overcomes the problem of the account for the statistical noise (e.g., the consequences of inadvertently omitting a relevant variable from the production model). However, it comes with certain weakness as well. SFA does not permit the prediction of the technical efficiencies of the units that produce multiple outputs (Coelli et al., 2005). In addition, with the use of price and quantity data, additional measurement errors may be added to the results. Therefore inefficiency causes might be due to the technical or allocative efficiency or combination of both (Kooreman, 1994). Detailed information about Stochastic Frontier Analysis can be found in the studies of Coelli et al. (2005) and Jacops et al. (2006).

2.2.3. Total Factor Productivity Indices

Total Factor Productivity (TFP) is defined as a ratio of aggregate outputs produced relative the aggregate inputs used. Change (increase or decrease) of the productivity can be represented by TFP, in the case of units producing multiple outputs using multiple inputs. TFP overcome the leakages of ratio analysis and integrates multiple inputs and outputs into a single performance ratio. Index numbers, used by TFP, can provide to measure price and quantity changes over time, and also measures differences across the units (Ozcan, 2008).

The most common used indices are Laspeyres index, Pasche index, Fisher index, Tornqvist index and Malmquist index (Coelli et al., 2005). First four indexes can only used with panel or cross-sectional data to measure the efficiency of two units in single time period or efficiency of one unit in two time period. In other words these indexes cannot analyze the efficiencies of more than two units at the same time or over time. However, this problem might be overcome by using Malmquist index.

It is possible to compare the efficiencies of many units in the cross-sectional time series with the usage of Malmquist index. According to this specification, Malmquist index has become a commonly used measure of productivity change and has gained importance in the literature. This index is constructed by measuring the radial distance of observed output and input vectors in the period t and $t+1$, based on the reference technology. More detailed information about Malmquist index can be found in the Chapter 5.

3. HEALTH CARE EFFICIENCY ANALYSIS

3.1. Assessing Hospital Efficiency

Efficiency generally refers to using minimum amounts of inputs for a given amounts of outputs. Thereby hospital efficiency indicates the health care facility produces a given level of care or quantity that meets an acceptable standards or quality by using minimum combination of resources (Ozcan, 2009).

In recent years efficiency has become one of the most attractive work areas of health care management literature. According to the one school in health care literature, hospitals are not profit-maximizing entities, and historically, most have not been overly concerned about negative margins or break even income statement. While other school argues that hospitals are profit organizations (White and Ozcan, 1996; Ferrier and Valdmanis, 2004; Langabeer, 2008). Hospitals, whether are economic organizations or not, have limited resources to gain maximum value as most other organizations (Watcharasriroj and Tang, 2004; Harris et al., 2000).

Efficiency evaluation provides information for lacking organizations and demonstrates how to improve performance for hospitals. Formerly, hospitals had to afford to meet the increased demand of their patients by only decreasing their operational costs. In this parallel most of the hospital was first to cut costs or avoid cases that would likely lose money. However, later health care administrators realized that the appropriate solution to keep their hospitals financially viable was to improve their performance. Efficiency analysis based on optimization techniques and their normative structure creates the benchmark for the hospitals. This is one of the most essential requirements of health care industry today (Ozcan, 2008).

During the past few decades, parametric and non-parametric techniques have been increasingly performed to analyze the efficiencies of hospitals. Hospital administrators should apply these efficiency techniques, based on a benchmark approach, in order to carry out the effective utilization of their resources and high quality medical outcomes. In this context, efficiency should be viewed as a relative measure across hospitals. Thereby, different hospitals in one time or single hospital in multiple times can be compared by using efficiency analysis.

Studies on hospital efficiency mostly focus on the issue of maximum gain with limited resources (Sorkis and Talloru, 2002). As clearly documented by Cetin (2007) who examines the effects of capacity and resource management decisions on cost, quality and financial performance in Turkish hospitals, one of the frequently raised issues on these studies is the efficient use of resources and controlling the costs. Thus, the interest on hospital efficiency has increased because of the desire to control the increasing costs. Accordingly, hospital resources and their processes became critical and the number of efficiency studies has increased in recent years.

As mentioned in the previous section, efficiency generally refers to using the minimum amount of inputs in order to produce expected outputs. Thereby, efficient care reflects a hospital produces a given level of care or quantity that meets an acceptable standard of quality, using the minimum combination of resources (Ozcan, 2008).

Regression analysis, ratio analysis and non-parametric techniques were applied to analyze the hospital efficiency in the previous studies (Ferrier and Valdmanis, 2004). DEA is one of the most applied methods for evaluating hospital efficiency (Linna et al., 2006; Bakar et al., 2010). DEA enables the use of multiple inputs and outputs at the same time for hospital efficiency studies.

Theoretical development of the DEA started by the studies of Charnes et al. (1978) which measures the efficiencies of Decision Making Units (DMUs). Data

Envelopment Analysis is a non-parametric linear programming technique that assesses the efficiency frontier by optimizing the weighted outputs to inputs.

As compared to other techniques, DEA models can provide the new solutions to increase the efficiency. DEA identifies the optimal ways of efficiency for each of the hospital rather than the averages. Since this is an appropriate way to understand the individual hospital efficiency, DEA provide the significant findings for the improvement process of hospitals. Hospitals can not only find their efficiency level, but also discover the alternative solutions to eliminate the inefficiency causes.

Since Nunamaker (1983) published the first health care efficiency analysis comparing small hospitals in Wisconsin, utilization of efficiency analyses in health care has become widespread. Besides, the study of Sherman (1984) was first in using DEA to analyze overall hospital efficiency.

Literature review of DEA studies on hospital efficiency shows that there are a number of studies applied in USA, Austria, Germany, Greece, Taiwan, Spain, Thailand, Norway, Ireland, Finland and most of other developed countries. *Number of beds, specialists, medical practitioners, medical stuff, and manager* are seen to be most frequently used input variables in these studies. *Number of inpatients, outpatients, surgical operations, visitors, and patient days* are seen to be most frequently used output variables. Also *degree of training, technology, number of clinic, laboratory, morbidity, mortality, and proprietary capital, costs of medical services, management, discharge, payment, and total profit* are seen to be used for DEA variables in such studies.

Several researches in the past focused on the effect of hospital ownership on hospital efficiency (e.g. Biqrn et al., 2003; Burgess and Wilson, 1998; Chang, 1998; Chang et al., 2004; Gannon, 2005; Grosskopf et al., 2001; Helmig and Lapsley, 2001; Hofmarcher et al., 2002; Ramanathan, 2005; White and Ozcan, 1996*)*. Most of these studies found that hospital ownership has a critical role on efficiency. In addition, Biqrn et al., (2003), Grosskopf et al., (2001), Helmig and Lapsley (2001), and Ramanathan (2005) used Malmquist Productivity Index (MPI) to evaluate the performance changes in time series. In line with the past studies, the influence of hospital ownership on the efficiency of Turkish hospitals and the efficiency changes in years 2001 and 2008 have been analyzed in the current study.

Although the use of DEA within hospital efficiency analysis is widespread for research publications, health care managers have not adopted DEA as a standard tool for performance measurement, especially in developing countries such as Turkey. This gap is caused by the complicated mathematical structure of DEA and to the failure of DEA specialist who have not provided the adequate bridge between theory and practice (Ozcan, 2008). Nevertheless, one of the principal objectives of this study is to provide practical implications, leaving the sophisticated formulations in the background, according to the efficiency results for health care policy makers in Turkey. The current study can enable hospital managers to understand the main structure of efficiency analysis thus it can be possible to take decisions based on DEA results.

Consequently, DEA can provide the following practical implications to hospital administrators:

- Analyze their hospital's relative performance
- Identify the top efficient hospitals in the health care sector
- Analyze the efficiency trend of their hospital
- Analyze the inefficiency causes of their hospital
- Analyze the main inefficiency causes of health care sector
- Provide practical implications to improve their efficiency

3.2. Hospital Efficiency, Service Quality and Patient Satisfaction

Quality, in general terms, refers meeting and exceeding customer expectations. Parasuraman et al. (1988) define service quality as the degree and direction of discrepancy between the consumer's perceptions and expectations. Meeting patients' needs and expectations is crucial for high quality care perception (Ramachandran and Cram, 2005; Yee et al., 2010). Recent years have brought a renewed emphasis on patient involvement in health care policies due to perceived service quality (Baggott, 2005). This is because the passive role of patients is being replaced by an active demand for personalized, caring and well-mannered service; therefore, health care providers are under an increasing pressure to be more attentive to patient satisfaction (Ruyter and Wetzels, 1998). Assessment of patient satisfaction is inevitable for quality improvements in health care management (Turner and Pol, 1995) and service quality is expected to increase satisfaction (Etgar and Fuchs, 2009).

Tiemann and Schreyögg (2009) argue that quality of care is one of the major objectives for hospitals, in addition to efficiency with regard to the character of hospital services. Most of the previous studies have examined only the link between perceived service quality and satisfaction in the health care sector (e.g., Zineldin, 2006) while there have been only a few attempts to include quality assessment corporate with efficiency analysis. For example, Nayar and Ozcan (2008) used quality-adjusted model to evaluate hospital performance in the sample of Virginia hospitals. They used quality measures as additional outputs in the model. Similarly, Harrison and Coppola (2007) added quality dimension in their hospital efficiency model. Most recently, Harrison et al. (2010) used quality as a dependent variable while efficiency is an independent variable in their study by using multiple regression analysis in the sample of US teaching hospitals.

Hospital operations are affected by increased demand for quality and efficiency. This entails the debate concerning the inevitable trade-offs between efficiency and quality (Athanassopoulos and Gounaris, 2001). As Kuwabara et al. (2010) stated health care systems have to achieve two major challenges: (1) improvement of the quality and safety of medical care; and (2) improvement the health care efficiency. Hospital efficiency and service quality trade-off can be illustrates in the following figure:

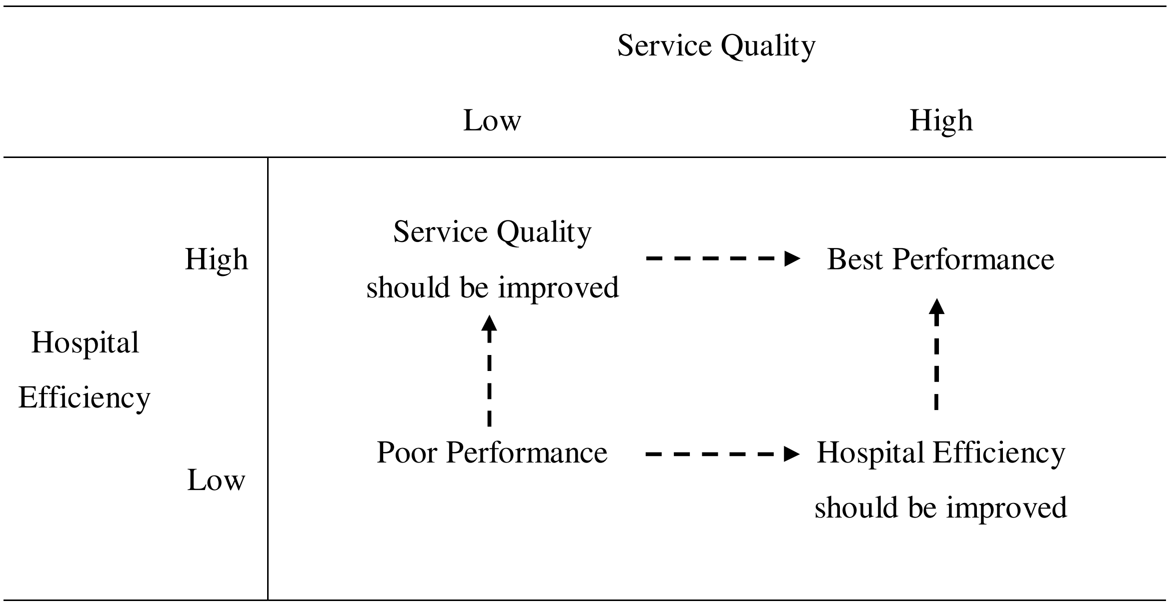


Figure 3.1. Hospital Efficiency and Service Quality Trade-off

The relationship between efficiency and quality can be defined in two different ways. Firstly, the most widely known traditional approach assumes a negative trade-off between efficiency and quality. The possible reason of this negative relationship might be the dissimilarities in efficiency and quality of care due to the substantial differences in objectives, incentives, and control mechanism (Tiemann and Schreyögg, 2009). Similarly, Valdmanis et al. (2008) states that quality improvement can result in greater resource use; therefore, it may require more or better resources.

Conversely, second type of relation between quality and efficiency known as the Total Quality Management (TQM) approach emphasizes that improvements in quality have positive effect on efficiency (Prior, 2006). TQM hypothesizes that it is possible to increase quality by efficiency gains. In this study, we also try to examine this controversial relationship between quality and efficiency in hospitals in order to evaluate both traditional and TQM approaches.

Many of the Turkish hospitals have implemented TQM programs in order to increase their level of effectiveness and service quality (Aydın et al., 2009). Shortell and Bennett (1998) state that %70 of US hospitals applied TQM and Continual Quality Improvement (CQI) programs for the same reason. Bosworth et al. (2005) also confirmed that progress in quality improvement contribute the effectiveness growth. Since the major goal of the health care administrators should be the maximization of the welfare of treated patients, in pursuit of better service quality (Chang et al., 2010), quality improvement programs have become essential for hospitals. TQM can be seen as an appropriate solution to improve both efficiency and effectiveness of health care (Kanji and Sa, 2003).

Gill and White (2009) reviewed the service literature for patient satisfaction and service quality and they concluded that there is no universally accepted conceptualization for these constructs. Additionally, Lengnick-Hall (1995) states that management of the relationship between service quality and patient satisfaction is inadequate according to traditional health care views. However, in today's highly competitive health care sector, one of the most essential aspects of health care improvement plans and reforms is to provide high quality of care while increasing efficiency.

In this parallel, Karagoz and Balcı (2007) state that management has a critical role in solving health care problems in world health circle. Kenagy et al. (1999) believe that the improvements on the dynamics of inefficiency such as wasted effort, redundant repetition and misuse of skilled staff will result in service quality improvements.

Consequently, patient satisfaction could be increased with such improvements. Similarly, Rivers and Glover (2008) argued that quality and process improvements conduce to decreased costs, which in turn result in increased patient satisfaction.

Furthermore, health care quality and hospital efficiency have been previously studied largely from the clinical or technical perspective, excluding the patient's perceptions (Gill and White, 2009). Although Garcia-Lacalle and Martin (2010) examined the relationship between hospital efficiency and perceived quality on the perspective of patient satisfaction, they did not include the technical and functional issues of service quality. As Herrmann et al. (2000) argued the linkage between internal quality improvement (technical quality) and external measures of customer needs and satisfaction (functional/perceived quality) is a complex structure. Herrmann et al. (2000) believe that, marketing approach focus on customer needs and satisfaction while engineering based approach focus on a technical quality issues. These approaches should be employed cooperatively to increase health care performance. Therefore service quality should be improved both in technical and functional perspectives in order to increase institutional performance. In this study, service quality is considered both from technical and functional perspectives.

4. TURKISH HEALTH CARE SYSTEM

Health care services are provided by the government and the private sector in Turkey. Public and private hospitals are affiliated to the Turkish Ministry of Health (TMoH). The public hospitals, founded by government are the major health care providers in Turkey. Financing of the public hospitals has been extremely centralized by Turkish Ministry of Health for allocating health care resources. In addition for-profit private hospitals provide health care services to the citizens based on determined payment rates by government.

During the history of the Turkish Republic, the health policies experienced some fundamental changes. Some of the important milestones are Refik Saydam era (1923), Behçet Uz era (1946) and the introduction of socialization in health services practice (1963). Since the early 1980s, socialization of health services was adopted. In 1990 State Planning Organization prepared a basic plan on the health sector. This "Master Plan Study on Health Sector" which was conducted by the Ministry of Health and the State Planning Organization is the beginning of a health reforms in a way. Then Turkish Ministry of Health prepared the "The National Health Policy" in 1993. This policy included five main chapters such as support, environmental health, lifestyle, delivery of health services and goals for a healthy country (Akdag, 2009).

As Kuwabara et al. (2010) stated health care systems have to achieve two major challenges by health care reforms: (1) improvement of the quality and safety of medical care; and (2) improvement the health care efficiency. In order to achieve this challenge, Performance-Based Payment System (PBP) has been implemented across Turkey since 2004 (Aydın and Demirel, 2007).

The 9th Development Plan, which was prepared in accordance with the aims of Health Transformation Program in 2006, anticipates facilitating access to health services, improving the service quality, strengthening the planning and supervising role of the Ministry of Health, developing health information systems, providing the rational use of drugs and supplies and, establishing a universal health insurance system(Akdag, 2009).

Being implemented in this scope, Health Transformation Program is the supplementary part of the national policy. By realization of this program, health services are gaining a dynamic base which will meet the rapidly changing and transforming health priorities. The historical backgrounds of Turkish Health care System and health related policies were presented in the following section with reference to the studies of Akdag (2009).

4.1. Historical Background of Turkish Health Care System

The Ministry of Health of Turkey was established by the Law No: 3 and dated 3 May 1920. The focus was mostly on recovering the damages of the war and developing legislations but could not allow a regular health recording system in the first years of Turkish Republic. The significant developments of the health services were realized during the years between 1923 and 1946. Health policies in this period can be defined with the following principles:

- Central execution of the planning, programming and administration of the health services by sole authority,

- Separation of preventive medicine and curative services by deploying their implementation to respectively central administration and local administration.

- In order to meet health manpower demand, improving the attraction of Medical Schools, establishing dormitories for medical school students, establishing compulsory duty for graduates,

- Introduction of control programs for communicable diseases such as malaria, syphilis, trachoma, tuberculosis and leprosy.

The "First Ten-Year National Health Plan", called the first health plan in the history of the Turkish Republic, was approved by the Higher Council of Health in 1946. Although National Health Plan could not have been turned into a legal text or implemented entirely, majority of its notions deeply influenced the health structuring of Turkey. The inpatient treatment institutions, which were basically under the supervision of the local governments until that day, were started to be managed from the centre. In the following years, significant progress was achieved in terms of health facilities and human health resources aiming health centers, maternal hospitals and infectious diseases.

As an extension of the first Ten Year National Health Plan, "National Health Program and Studies on Health Bank" was announced in 1954. This program has become one of the foundation stones for the health planning and the organization for Turkey. The National Health Plan categorized the country into seven health regions, and aimed to establish the faculty of medicine in each region in order to increase the number of physicians and other health staff. The numbers of hospitals and health centers were increased and within the same framework as well as the increase in the number of beds was also ensured. Among the special service fields, the increase in the numbers of pediatric hospitals, maternal hospitals and tuberculosis services was quite promising.

The Law No 224 on the Socialization of the Health Services was adopted in 1961. The socialization actually had begun in 1963 and became widespread in 1983. A structure was established as health posts, health centers, and province and district hospitals through a widespread, continuous, integrated, and gradual approach. "Basic

Law on Health Services" was adopted in 1987. In 1990 the State Planning Organization (SPO) prepared a basic plan on the health sector. This "Master Plan Study on Health Sector" which was conducted by the Ministry of Health and the State Planning Organization is the beginning of the health reforms in a way.

The main features of the Health Reform activities which were conducted in 1990's were:

- Establishment of a Universal Health Insurance by gathering the social security institutions under one umbrella,
- Development of the primary health services in the framework of family medicine,
- Transformation of the hospitals into autonomous health facilities,
- Providing a structure to the Ministry of Health which plans and supervises the health services prioritizing preventive health services.

4.2. Health Transformation Program

Turkish Ministry of Health declared Urgent Action Plan that aim to develop basic health objectives in 2002. As soon as determination of the Urgent Action Plan the Health Transformation Program was prepared and announced to the public opinion by Turkish Ministry of Health. The Health Transformation Program aims transformation in the framework of following issues (Akdag, 2009):

- Ministry of Health as the planner and supervisor,
- Universal health insurance gathering everyone under single umbrella,

- Widespread, easily accessible and friendly health service system,
    - Strengthened primary health care services and family medicine,
    - Effective and staged referral chain,
    - Health facilities having administrative and financial autonomy,
- Health manpower equipped with knowledge and skills, and working with high motivation,
- Education and science institutions to support the system,
- Quality and accreditation for qualified and effective health services,
- Institutional structuring in the rational management of medicine and supplies,
- Access to effective information at decision making process: Health information system.

The above mentioned principles and goals of Health Transformation Program have been implemented by TMoH. Health Transformation Program still continues with the strategic objectives of the Ministry of Health.

4.3. Performance-Based Payment System

Performance-based payment system, one of the main parts of Health Transformation Program, has been implemented in all health care institutions since 2004. This system aims to improve health care services by measuring individual performance to promote high quality and efficient service provision. PBP system has brought about comprehensive changes in the health care system. First, a system was setup by monetary contribution which would ensure more productive use of time and health care resources. Secondly, the services provided in hospitals have become measurable for evaluating performance. Through this policy, provided services have been registered, the leakages in the system have been avoided and the majority of the physicians are forced to work full time in hospitals. Additionally, PBP system has increased the satisfaction of patients and health care personnel which in turn improved service efficiency (Akdag et al., 209). According to PBP system, hospitals are encouraged not to spend more than the initial budget assigned, therefore, they have a clear motivation to save costs and improve efficiency (Jegers et al., 2002).

Performance-based payment is being implemented in all health facilities affiliated to the Ministry of Health which is determining the rate, principles and procedures of the supplementary payment to be made to the staff assigned from the revolving capital incomes in order to ensure that health services are improved, and quality and efficient service provision is encouraged. Turkish Ministry of Health define the PBP system that it is not only a monetary payment model, it is an application which rewards the staff according to “success criteria” determined, and ensuring saving, efficiency and productivity together with the “corporate performance criteria” in addition to increasing individual efficiency. Performance-based payment system, being a dynamic application, has been continuously developed since the date on which it was launched and renewed according to the strategic targets of the Ministry of Health (Aydın and Demirel, 2007).

An extended implementation was also initiated to evaluate the hospital performance and quality of care, which was integrated into the PBP system since 2005. Thereby, the inspection model was formed through hospital performance and quality development methods by the directive of Turkish Ministry of Health. This directive has comprehensive changes with respect to the quality implementation in health and it covers both public and private hospitals. With this extension, the concept of quality of care was also included to the PBP system.

As a result of an integrated performance and quality development system related to reimbursement principles, health care professionals depend not only on quantity of services produced but also on the results of quality of care. This system has played an important role to overcome the workload created by the increasing patient demand at the hospitals. Thus, the productivity of the physicians has increased in the Turkish hospitals (Akdag et al., 2009). As a reflection of this, a period of health reform is currently underway in Turkey where the efficiency and quality of care are prioritized (Sezen and Gok, 2009a).

The implementation of the PBP system for public and private hospitals gives patients the right to choose their hospitals. Thus, hospitals provide more patient-oriented care and patients take more roles in the health care processes. Since patient's decision is affected by the price and/or quality, this freedom will lead to improved service quality (Garcia-Lacalle and Martin, 2010). PBP system played an imperative role for raising the motivation in meeting the patient demands. Through this system, waiting hours are shortened; referrals to upper level hospitals are lowered to reasonable degrees and the income-expenditure balance of hospitals is cautiously managed. In addition, PBP system eliminates problems in the recording system and inexpensive provision of supplies and decreases waste (Akdag et al., 2009). It is expected that the PBP system could increase the efficiencies and the productivities of hospitals in Turkey.

5. METHODOLOGY

5.1. Data Envelopment Analysis

Data envelopment analysis (DEA), mainly based on the earlier concept of Frontier Analysis (Farrell, 1957), is one of the most consequential techniques to analyze the efficiencies of health care organizations such as hospitals. DEA assesses the relative efficiency scores of a particular set of Decision-Making-Units (DMUs), which produce a variety of outputs by using several inputs. Unlike traditional parametric estimation methods, DEA does not impose specific functional forms between inputs and outputs, and it provides comprehensible information about the sources and magnitude of inefficiencies of a DMU (Chen et al., 2005).

Instead, DEA resembles piecewise linear functions, where the approximations are described endogenously to envelop the data tightly (Chang et al., 2004). This approach uses a mathematical programming method to create a set of weights for each inputs and outputs, which considers how efficiency in the DMUs can be improved, and ranks individual DMUs based on efficiency score (Liu et al., 2007). DEA has been broadly used to expand the assumptions on functional form and stochastic structure (Ouellette and Vierstraete, 2004). Therefore DEA technique can avoid the risk of misspecification of production function, which is one major drawback of traditional regression analyses (Watcharasriroj and Tang, 2004).

A vector of inputs and outputs are analyzed to identify the relatively most efficient decision-making unit in the set of similar and homogeneous DMUs (Ancarani et al., 2009). One of the key advantages of the DEA technique is substitution within both inputs and outputs. This feature can capture the indispensable characteristics of hospitals that accommodate multiple inputs to produce the services (Watcharasriroj and Tang, 2004).

The first DEA model developed by Charnes, Cooper, and Rhodes (1978), named the CCR model, was based on the assumption of constant return to scale (CRS). Then, Banker, Charnes, and Cooper (1984) enhanced the CCR model and developed the BCC model using the variable return to scale (VRS). Efficiency frontier has constant slope and is positioned through the DMUs with equally highest input-output ratio in the CRS assumption. In spite, VRS frontier consists of a series of segments displaying varying non-negative slopes positioned through the DMUs with the highest input-output ratios given their scale of operations (Vitikainen et al., 2009). Therefore, pure technical efficiency (PTE) scores are always equal or more than technical efficiency (TE) scores. The inefficiency causes could be deeply analyzes both using CRS and VRS assumption with regarding to evaluate technical and pure technical efficiency (Cooper et al., 2007).

DEA aims to find DMUs that produce the highest levels of outputs by using the lowest levels of inputs. Therefore, it maximizes the ratio of weighted outputs to weighted inputs for the DMU under consideration (Sezen and Gok, 2009b). This maximization objective is subject to the constraint that the same ratio for all DMUs be less than or equal to one. This leads to the following model, in which one can find the efficiency value for DMU *m* (Ramanathan, 2005):

$$Max \frac{\sum_{j=1}^{J} v_{mj} y_{mj}}{\sum_{i=1}^{I} u_{mi} x_{mi}} \qquad (5.1);$$

$$0 \le \frac{\sum_{j=1}^{J} v_{mj} y_{nj}}{\sum_{i=1}^{I} u_{mi} x_{ni}} \le 1; n = 1,2,......., N$$

$$v_{mj}, u_{mi} \ge 0; i = 1,2,......, I; j = 1,2,....., J \qquad (5.2);$$

Here, *i* is the index for inputs, *j* is the index for outputs, and *n* is the index for DMUs. The variables v_{mj} and u_{mi} are the weights representing the importance of each input and output. If the efficiency score is equal to 1, the DMU *m* is located on the efficiency frontier. Here, the efficiency value is a relative measure indicating how DMU *m* operates compared to the other DMUs that are included in the sample. Detailed discussion of DEA model could also be found in the studies of Cooper et al. (2004).

In the health care sector, Data Envelopment Analysis (DEA) has been the most frequently used technique for measuring efficiency (Hollingsworth, 2008). DEA is a non-parametric approach that uses linear programming technique for analyzing the relative efficiencies of individual Decision Making Units (DMUs) with respect to multiple inputs and outputs. Relative efficiency of each DMU (hospital in our case) is analyzed as the ratio of the weighted sum of its outputs to the weighted sum of its inputs in DEA model. DEA finds the most favorable set of weights for each DMU (Weng et al., 2009). After analyzing efficiencies, an efficiency score (θ) of 1 is dispense to those DMUs that have maximized the use of inputs for the production of outputs. An efficiency score (θ) that different than 1 is considered to be inefficient and is a relative representation of the overuse of inputs to outputs (Lambiase and Harrison, 2007).

DEA is popular in evaluating hospital efficiency because it is applicable to the multiple input-output that is essential for the nature of a health care system (Hollingsworth et al., 1999). In this study, number of specialists, number of medical practitioners and number of beds are used as input variables; while number of outpatients, discharge number, number of surgical operations (categorized as small, medium and large), number of births, bed utilization rate, average inpatient days, bed turnover rate, and ratio of inpatients to outpatients are used as output variables.

Scale efficiency is defined as a ratio of CCR and BCC efficiency scores. Therefore CCR and BCC model should be determined for deeply understanding of scale efficiency. The CCR model assumes the Constant Return to Scale production set. This model is postulated that the radial expansion and reduction of all DMUs, therefore, the

CCR score is called (global) technical efficiency. The BCC model assumes that convex combinations of the DMUs and the BCC score is called pure technical efficiency. If a DMU is fully efficient (100%) in both the CCR and BCC scores, it is operating in the Most Productive Scale Size (MPSS). If a DMU has low CCR score but a full BCC efficient but, then it is operating locally efficiently but not globally efficiently through to the scale size of the DMU. Accordingly, scale efficiency of a DMU could be demonstrated by the ratio of CCR and the BCC scores (Cooper et al., 2007). Let the CCR and BCC scores of a DMU be θ_{CCR} and θ_{BCC} respectively. The scale efficiency is defined by,

$$SE = \frac{\theta_{CCR}}{\theta_{BCC}} \qquad (5.3);$$

Technical Efficiency takes no account of scale effect as distinguished from Pure Technical Efficiency (PTE); hence SE is not greater than one (Cooper et al., 2007). According to these concepts relationship decomposition of efficiency could be demonstrated as,

[Technical Efficiency (TE)] = [Pure Technical Efficiency (PTE)] x [Scale Efficiency (SE)]

Following figure illustrates the components of DEA efficiency. In this figure, the concept of allocative efficiency is not comprehensively defined because of it is not used in the current study.

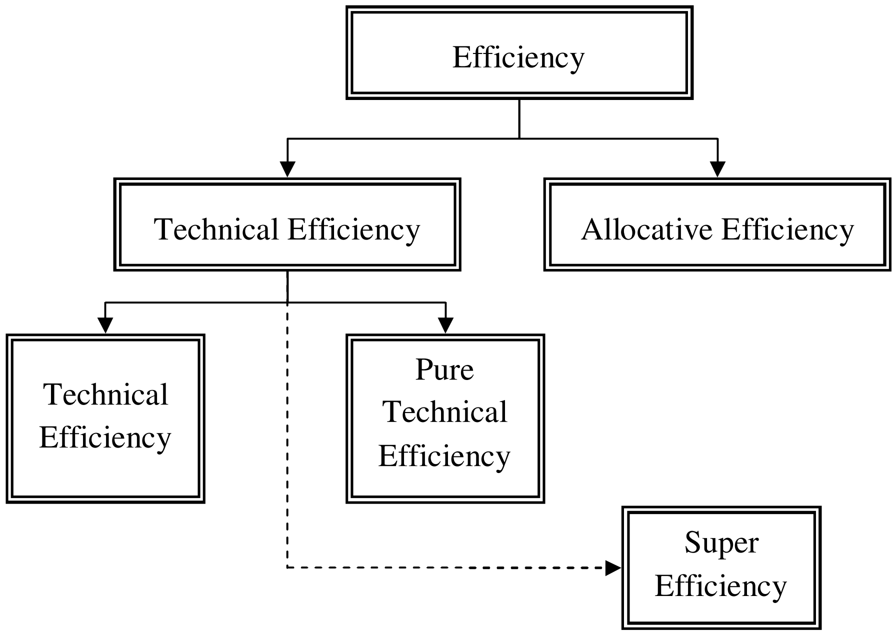


Figure 5.1. Components of Efficiency

In accordance with these concepts MPSS ratio of a set of observed DMUs should be defined as,

MPSS Ratio = [Number of DMUs that fully efficient in both CCR and BCC scores] / [Number of observed DMUs]

Inefficiencies of hospitals are assessed by analyzing the slacks of inputs and outputs. Using the results derived from this CRS DEA model, we measure the differences in the slack values of both inputs and outputs for the hospitals. The reason of choosing the CRS model for examining the slack values is to measure the input-output correspondence without any absent of any scale or congestion effects. The identification of slack values can provide the detailed information about the inefficiency causes of hospitals to the individual hospital managers. Therefore this analysis can provide the evidence for hospital administrators that how much their hospital needs to increase inputs and/or decrease outputs as compared with their hospital's peer groups.

Although DEA is a useful optimization technique to analyze the efficiencies of each DMU, it has a limitation about the number of inputs and outputs. Many organizations have lots of inputs and outputs, especially for service organizations. When one needs to analyze the efficiencies of small number of DMUs with using all inputs and outputs, discrimination power of DEA will be limited. However this problem could be overcome by only including inputs and outputs which provide the essential contribute to the production process of DMU. Thereby, relatively unimportant input and output variables are eliminated. This is generally performed by eliminating one of pair of factors which are strongly positively correlated with each other (Ozcan, 2008).

5.1.1. Model Orientation

DMUs' scores are compared with one another and the set of most effective DMUs is called *"efficiency frontier"* (Junoy, 2000). In this benchmark model there are two assumptions: (1) *input oriented* (while outputs are hold constant and inputs are decreased), (2) *output oriented* (while inputs are hold constant and outputs are increased), (Harris et al., 2000). Although some authors used output oriented approach to analyze hospital efficiency with DEA (Biqrn et al., 2003; Hu and Huang, 2004) majority of the past studies suggested the input oriented approach for measuring hospital efficiency (Aletras et al., 2007; Cooper et al., 2007; Ferrier and Valdmanis, 2004). The reason is that the hospitals have inconsiderable control over their outputs, like increasing the patient days, but more opportunities to reduce the inputs (Lee et al., 2009; Aletras et al., 2007; Butler and Li, 2005).

In other words, health care organizations are generally considered to have limited control over their outputs such as inpatient days or discharges. However, it is more appropriate to assume that health care organizations have more control over the utilization of resources. Therefore, an input-oriented DEA model is mostly implemented for analyzing efficiencies of hospitals (Aletras et al., 2007; Athanassopoulos and

Gounaris, 2001; Butler and Li, 2005; Kazley and Ozcan, 2009; Kontodimopoulos et al., 2006; Ozgen and Ozcan, 2004).

In the present paper an input oriented model has been considered appropriate. This is because the input oriented approach allows for the fact that hospitals are assigned an incontrollable quantity of outputs, and therefore efficiency should be pursued by minimizing inputs. Particularly hospital administrators have more control on input items that used in this study such as number of beds or number of physicians than number of patient related output variables. In addition survey results that describe above, show us that hospital chief officers especially mentioned the importance of input related items. Consequently input oriented DEA model preferred in the examining the efficiencies of Turkish hospitals.

5.1.2. Frontiers Model

There are two types of DEA frontier models which might be used depending on the requirements of the optimization problem. As we mentioned above, the initial frontier model, Constant Return to Scale (CRS), was developed by Charnes et al. (1978). Banker et al. (1984) enhanced the CRS model and developed the Variable return to Scale (VRS) DEA model. VRS model assume that the scale of economies can be changed as size of the DMU increases. Following figure present the DEA frontier models and model orientations.

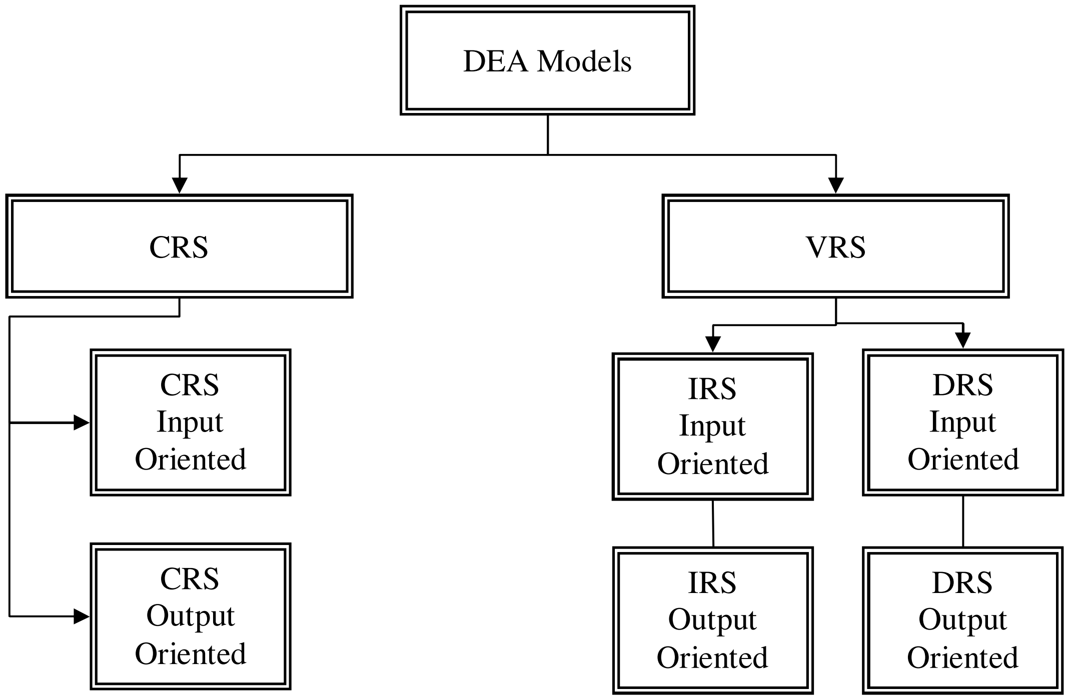


Figure 5.2. DEA Frontier Models and Model Orientations

The CRS models assume a constant rate of substitution between inputs and outputs. The fundamental structure of the CRS model is the ratio of maximization of the ratio of weighted multiple outputs to weighted multiple inputs. Mathematical formulation of CRS - DEA model can be shown in the following equation (Charnes et al., 2007):

$$Maximize\,\theta_t = \frac{\sum_{r=1}^{s} u_r y_{rt}}{\sum_{i=1}^{m} v_i x_{it}} \qquad (5.4)$$

$$subject \quad to \quad \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \qquad (5.5)$$

$u_r, \; v_i \; \geq 0 \; for \; all \; r \; and \; i.$

The efficiency scores (θ_t) for group of DMUs (j = 1, … , n) are computed for the selected outputs (y_{rj} , r = 1, … , s) and inputs (x_{ij} , i = 1, … , m) using the above fractional programming formula. In this formulation the weights of inputs and outputs are u_r and v_i, respectively. (θ_t) represent the efficiencies of individual DMU.

DEA provide the solution of a group of optimally performing DMUs which are defined as efficient. Efficiency scores of these DMUs are one. These efficient DMUs are used to create an *efficiency frontier*. Accordingly, DMUs which produce less weighted outputs per weighted inputs and/or used relatively more weighted inputs to produce outputs can be identified as an inefficient. The efficiency scores of inefficient DMUs are less than one and greater than zero.

Since the impact of scale economies and other several reasons the substitution for efficiency frontier may not be constant in all cases. As an example, if a relative decrease one or more inputs can cause greater than relative decrease in outputs, constant return to scale is not appropriate. This situation raises the notion of Variable Return to Scale (VRS).

VRS efficiency can be decomposed into two components namely, (i) Increase Return to Scale (IRS) and (ii) Decrease Return to Scale (DRS). Sum of the lambda (λ) weight values is used to calculate the situation of return to scale whether it is increasing or decreasing. Following equations can be drawn:

If $\Sigma \lambda < 1.0$, then this DMU exhibits increasing return to scale

If $\Sigma \lambda > 1.0$, then this DMU exhibits decreasing return to scale

If $\Sigma \lambda = 1.0$, then this DMU exhibits constant return to scale

The difference between IRS and DRS can be defined as the changing ratio of inputs and outputs for inefficient hospitals due to the axis of efficiency frontier. If the changing ratio of the decreasing of inputs is greater than the changing ratio of increasing outputs for any inefficient DMU, this called as a decreasing return to scale. The opposite of this is called as an increasing return to scale. Detailed information about return to scale can be found in the study of Cooper et al. (2007).

5.1.3. Inefficiency Analysis

Decision Making Units have efficiency scores different than one and greater than zero are defined as inefficient. These DMUs can improve their efficiency or reduce their inefficiencies by reducing their inputs and/or increasing their outputs. Inefficiency analysis provides the evidence about which inputs are needed to be reduced (input reductions) or which outputs are needed to be increased (output augmentation). In some cases, these input reductions and output augmentations are also called as slacks.

Therefore, slacks only exist for inefficient DMUs which needed to improve their efficiency level. However, slacks represent only the leftover portions of inefficiencies; after proportional reductions in inputs or proportional augmentation in outputs, if a DMU cannot reach the efficiency frontier (to its efficiency target), slacks are needed to drive the DMU to the frontier (Ozcan, 2008).

Efficiency target input and output levels are analyzed for each DMU by using inefficiency analysis. These targets are the results of respective slack values added to outputs or subtract to inputs. In order to calculate target values for inputs and outputs, input slack is subtracted from the current input value or output slack added the current output value, respectively. Inefficiency is caused by non-effective use of the inputs and/or outputs (Cooper et al., 2004). Therefore evaluation of the slack for inputs and outputs is crucial for efficiency improvement.

For constraints with non-zero slacks, the efficiency of peer group suggests that the DMU under evaluation can enhance beyond the level implied by the overall efficiency estimate θ. For such inputs and/or outputs the estimated frontier effectively drives parallel to the relevant input or output axis in multidimensional space (Jacops et al., 2006). Targets for input and output variables could be calculated by the following formula for inefficient DMUs:

$$\hat{x}_i = x_i - s_i^- \qquad i = 1, \dots, m \qquad (5.6)$$

$$\hat{y}_r = y_r + s_i^+ \qquad r = 1, \dots, s \qquad (5.7)$$

In this formulation;

$\hat{x}_i$: efficiency target of ith input

x_i : current efficiency value of ith input

s_i^- : slack values of ith input

$\hat{y}_r$: efficiency target of rth output

y_r : current efficiency value of rth output

s_i^+: slack values of rth output

5.1.4. Super Efficiency Analysis

All 100% efficient DMUs will be called efficient in DEA. However it may not be argued that the efficiencies of all efficient DMUs are the same. Ranking among these efficient hospitals can be made by using the super-efficiency score (Zhu, 2003). Super efficiency model was first proposed by Andersen and Petersen (1993) as a CRS radial super efficiency model. These author defined super efficiency models where a DMU under evaluation is removed from the reference set were developed for the purpose of ranking efficient units. Super efficiency DEA models are based on a reference technology constructed from all other DMUs. The mathematical structure of the super efficiency analyses is shown in the following (Ramanathan, 2005):

$$\max \sum_{j=1}^{J} v_{mj} y_{mj} \text{ ; for, } \quad \begin{array}{l} \sum_{i=1}^{I} u_{mi} x_{mi} = 1; \\ \sum_{J=1}^{J} v_{mj} y_{mj} - \sum_{i=1}^{I} u_{mi} x_{mi} \leq 0; n = 1,2,.....,N; n \neq m \\ v_{mj}, u_{mi} \geq 0; i = 1,2,......,I;\ j = 1,2,.......,J \end{array} \quad (5.8)$$

The super efficiency scores of efficient DMUs is greater than one while the efficiency scores of inefficient DMUs is not change. Therefore, super efficiency values are solely used to rank the each efficient DMU and eliminate the ties that occur for efficient DMUs. Wilson (1993) suggest that super efficiency can be used to ranked the DMUs according to influence of the change of the technical efficiency. Other uses of this approach have also been proposed. For instance, super efficiency DEA models can be also used in detecting influential observations (Wilson, 1995) and in defining the extreme efficient DMUs.

Seiford and Zhu (1999) examine the various super efficiency models developed from envelopment models therefore, detailed information about other super efficiency models can be found in their study. However these super efficiency measures has some troubles. Troubles can range from a lack of units invariance for these measures and extend to non-solution possibilities when convexity constraints are to be dealt with (Cooper et al., 2007). Therefore in the current study radial super efficiency model, suggested by Andersen and Petersen (1993), is performed to rank the efficient DMUs.

5.2. Malmquist Productivity Index

The concept of Malmquist Productivity Index (MPI) was first introduced by Malmquist (1953), and has further been studied and developed in the non-parametric framework by several studies. MPI is an index representing Total Factor Productivity (TFP) augmentation of a DMU, in that it reproduces progress or regress in efficiency along with progress or regress of the frontier technology over time under the utilization of multiple inputs and multiple outputs (Tone, 2004).

MPI is used to show the differences in efficiency of hospitals by years. Parametric and nonparametric techniques could be used for productivity measurements. Nonparametric techniques have an advantage of not requiring a pre-determined functional form. Malmquist index based on data envelopment analysis is the most popular nonparametric technique for productivity analysis (Dimas et al., 2010).

The most common technique in data envelopment analysis literature is to implement the Malmquist Productivity Index of the change in Total Factor Productivity when longitudinal data or panel data are available. Index numbers are used to measure the change in TFP and involve the measurement of changes in the levels of output produced and input used. The most popular indices are Laspeyres index, Pasche index, Fisher index, Tornqvist index and Malmquist index as noted in the Section 2.2.3.

All indices measure the productivity changes between a base period and the current period. Measuring productivity change by using Laspeyres index, Pasche index, Fisher index, Tornqvist index requires price and quantity data as well as assumptions about the structure of technology. However, MPI does not need data on prices of inputs and outputs or technological or behavioral assumptions (Jacops et al., 2006). As Coelli et al. (1998) indicated, this specification makes the MPI a particularly feasible technique for the productivity analysis of service sector, where output prices are not in general available.

In the present study, CRS DEA-based Malmquist Productivity Index (MPI) is used to measure patterns of efficiency changes of DMUs. In MPI analysis, a set of observed DMUs across several time periods are used to create a panel. MPI enables a

DMU to be compared with itself in other time periods within the same panel and assesses the patterns of efficiency changes of DMUs over the time periods.

MPI can be used to monitor the specific position corresponding to each hospital and to evaluate changes in productivity (Chang et al., 2011). MPI compares productivity change from the base period represented by “period t” to the subsequent period represented by “period t+1” by calculating the ratio of the distance between two periods based on a common production technology (Chang et al., 2011). The contribution of scale economies can be assessed according to usage of CRS DEA efficiency scores in MPI analysis.

Malmquist productivity index under variable return to scale can be analyzed in a similar manner but also has another part to overcome with scale efficiency change (Cooper et al., 2004). The Malmquist Productivity Index attains a value greater than, equal to, or less than unity if a hospital has experienced efficiency indicates an improvement, stagnation or efficiency decline between periods *t* and *t+1* (Kirigia et al., 2008). Malmquist Productivity Index (Malmquist, 1953) is defined as follows:

$$M^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \times \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)}\right]^{1/2} \qquad (5.9)$$

In this formulation, D^t is a distance function measuring the efficiency of conversion of inputs x^t to outputs y^t in period t. (Fare et al., 1994).

The further advantage of the MPI technique is the decomposition feature of productivity change. MPI value can be decomposed into its component parts such as efficiency change and technical change. Fare et al. (1994) subsequently decomposed MPI into various sources of productivity changes. These analysts used DEA to examine the distance function to produce the MPI and then decomposed this into technical change and technical efficiency change components. According to this decomposition

MPI can also be considered as a geometric average of the effect of technology change and it can be written as:

$$M^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}\right] \times \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)}\right]^{1/2} \qquad (5.10)$$

or

M = Efficiency Change (EC) x Technology Change (TC), where

$$EC = \left[\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}\right] \qquad (5.11)$$

$$TC = \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)}\right]^{1/2} \qquad (5.12)$$

In accordance with above mentioned formulation MPI is defined as the product of "catch-up" and "frontier-shift" terms. The catch-up terms relates to the degree that a DMU attains for improving its efficiency, while the frontier-shift term reflect the change in efficient frontiers surrounding the DMU between the two time periods (Tone, 2004).

In other words, efficiency change is the relative efficiency shift between the periods and specifies the direction of change. In other words efficiency change finds out whether a hospital moves away from the efficiency frontier. While technology change reflects the shift of the efficiency frontier between the periods that indicates whether the reference set of a hospital improves, remains stable or deteriorates between the periods. Consequently, the performance of inefficient hospitals and efficient hospitals are examined by efficiency change and technical change, respectively (Dimas et al., 2010).

5.3. Non-Parametric Tests

5.3.1. Kruskal-Wallis Test

Kruskal-Wallis test could be used to analyze for differences between several independent groups. This non-parametric test is an alternative to one-way independent ANOVA test (Field, 2009). Kruskal-Wallis test, based on a ranked data, was first introduced by Kruskal and Wallis in 1952. This approach is the extension of the Wilcoxon rank-sum test which described in the following section, comparing more than two samples.

The primary difference between ANOVA and Kruskal-Wallis test is that the latter is based on a test statistics computed from ranks determined for pooled sample units. Its null hypothesis is that the rank assigned to a particular unit has an equal chance of being any number between 1 and n, regardless of the sample group to which it belongs (Lapin, 1993).

Therefore, efficiency scores are ordered from lowest to highest, ignoring the group to which the score belong, and then assign the lowest score a rank of 1, the next lowest a rank of two and so on. Then, the scores back into their groups and add up the rank for each group. Once the sum of rank has been calculated for each group, the test statistics (H) is calculated by the following formulation (Field, 2009):

$$\text{Test Statistics} \qquad H = \frac{12}{n(n+1)}\left(\sum_{i=1}^{k}\frac{R_i^2}{n_i}\right) - 3(n+1) \qquad (5.13)$$

In this formulation,

H : Kruskal-Wallis test statistics

n_i : number of measurements in sample *i*

R_i : rank sum for sample *i*, where the rank of each measurement is computed according to its relative magnitude in the totally of data for the *k* samples n : total sample size = $n_1 + n_2 + ... + n_k$

5.3.2. Wilcoxon Signed-Rank Test

Wilcoxon Signed-Rank test is used in situations in which there are two sets of scores, came from the same units, to compare. This test is the non-parametric equivalent of the dependent *t*-test. This test is free of the possibly invalid assumptions of normally may also be used to test independent samples (Field, 2009).

The Wilcoxon test compares two samples which are taken from two populations. All null hypotheses tested under this approach share a common assumption that the samples were selected from identical population, which is more stringent than assuming that they have identical means. Therefore, the Wilcoxon test is based on the principle that the two samples may be treated as if they came from a common population. The data for two samples may be combined under the null hypotheses. The observed values in the pooled sample are then ranked from smallest to largest. The smallest value is assigned a rank of 1, the next smallest value is ranked 2, and so on. The samples are then separated and the sums of the ranks are calculated for each sample. The rank sums obtained are used as a test statistics (Lapin, 1993).

The test statistics (z) can be calculated by using following formulation (McClave and Sincich, 2003):

$$\textit{Test statistics}: \qquad Z = \frac{T_1 - \frac{n_1(n_1+n_2+1)}{2}}{\sqrt{\frac{n_1 n_2 (n_1+n_2+1)}{12}}} \qquad (5.14)$$

In this formulation;

Z : Wilcoxon Rank Sum test statistics

T_1: sum of the rank in the group (smaller summed rank)

n_1: number of measurements in sample *1*

n_2: number of measurements in sample *2*

6. DATA DESCRIPTIONS

6.1. Data of Efficiency Analyses

Hospitals are arranged multifarious types by their specific character like ownership, structure and teaching properties in health care industry for assessing the efficiencies. As Lee et al. (2009) indicated, one of the major controversies in the field of health care is the effect of ownership on hospital efficiency. Hospital ownership in Turkey can be broadly classified into three major groups such as (i) functional ownership, (iii) teaching mission ownership and (i) profit seeking ownership.

According to the functional classification, Turkish hospitals are arranged in four groups by the ownership types: (i) public hospitals, (ii) education and research hospitals, (iii) university hospitals and (iv) private hospitals.

Hospitals are arranged two groups according to profit seeking ownership as (i) government or publicly owned and (ii) privately owned. Public hospitals are founded by Turkish Ministry of Health while private hospitals are founded by private capital. As Chang et al. (2004) stated, public hospitals are an operational unit of government funds; they typically do not have to assume the risk of profits or deficits, while private hospitals aim to maximize profits similar to other profit seeking institutions.

With regard to the teaching mission, hospitals classified as a (i) teaching and (ii) non-teaching hospitals. It is generally pointed out in the health care literature that teaching hospitals are more costly than their non-teaching counterparts (Langabeer, 2008). However teaching hospitals provide the essential sophisticated and specialized public goods like education and research (Grosskopf et al., 2001). On the other hand, Sloan et al. (1983) as well as Jensen and Morrisey (1986) stated that teaching function may negatively affect the efficiency of other hospital inputs, thereby decreasing the efficiency. Therefore, comparatively investigating the efficiencies of teaching and non-teaching hospitals is essential for better decision making in the health care industry.

Teaching hospitals are defined as hospitals with medical residents that receive specialized medical training such as having residency for becoming a specialized physician. Although in-service training is received to non-specialized physicians and/or nurses in public hospitals, these types of trainings are not categorized as residency or internship program for medical residents. Therefore education & research hospitals and university hospitals are defined as teaching hospitals due to the above mentioned properties.

Generally speaking, for-profit hospitals overemphasize the control of medical costs, and somehow this may lead them to lower the quality of care they provide. Non-profit hospitals, conversely, primarily emphasize to fulfill the demand for public goods or meeting unmet health care needs (Lee et al., 2009). Since organizational objectives, patient selection and case-mix differences differ as a result of profit gaining; we decided that it would be unfair to compare profit and non-profit hospitals in the same sample for comparing the efficiencies of teaching and non-teaching hospitals. Therefore, although for-profit hospitals are classified as non-teaching hospitals, only the public hospitals are used as non-teaching hospitals.

In this study questionnaire was used to identify hospital inputs and outputs. Survey was conducted on the chief officers of hospitals. The main reason for conducting the questionnaire is to see which factors are most important for evaluating the Turkish hospital efficiencies by the perspective of Turkish hospitals' administrators. Questionnaire was composed of three sections. In the first part, many possible input and output variables were described and the question of "*which variables are the most important for increasing the hospital performance*" was asked to the chief officers. In the second part, the respondent was asked to select from a set of input and output variables based on their perceived level of significance in contributing hospital efficiency. In the last part, the chief officers were asked to list the top five resources of hospitals from among 20 items. All of the items listed here were collected from the former studies concerning the hospital efficiency.

Consequently, hospital chief officers were presented with a list of possible input and output variables. However by being presented with a predetermined list of variables, the officers would not have the opportunity to provide their own list of variables that they are important to them. Therefore we added a blank section for participant in order to denominate their own ideas about inputs and outputs that have not predetermined in the survey. As a result of this survey the most preferred input and output variables were selected for further examination of hospital efficiencies.

After the survey, the selected input and output data were obtained from the Annual Statistical Health Report published by the Turkish Ministry of Health. The present study is based on the data collected from Turkish hospitals from 2001 to 2008. After eliminating hospitals with missing input and output variables, the number of hospitals in each year differed from year 2001 to 2008, as shown in Table 6.1 and Table 6.2.

Table 6.1. Sample Size of Hospitals (Functional Ownership)

		Functional Ownership			
	Total Number of Hospitals	Public Hospitals	Education & Research Hospitals	University Hospitals	Private Hospitals
2001	477	362	11	36	68
2002	504	372	12	36	84
2003	526	375	9	40	102
2004	566	398	10	40	118
2005	569	350	27	40	152
2006	608	360	24	41	183
2007	726	352	25	42	307
2008	741	366	22	35	318

Table 6.2. Sample Size of Hospitals (Teaching Mission Ownership and Profit Seeking Ownership)

	Teaching Mission Ownership			Profit Seeking Ownership		
	Total Number of Hospitals	Teaching Hospitals	Non-Teaching Hospitals	Total Number of Hospitals	Public Hospitals	Private Hospitals
2001	409	47	362	477	409	68
2002	420	48	372	504	420	84
2003	424	49	375	526	424	102
2004	448	50	398	566	448	118
2005	417	67	350	569	417	152
2006	425	65	360	608	425	183
2007	419	67	352	726	419	307
2008	423	57	366	741	423	318

Since MPI analysis requires a balanced data (Lin and Berg, 2008), all the decision-making units (DMUs) under evaluation are required to have complete data during the eight year period. Therefore, total numbers of hospitals are reduced due to the missing data of some hospitals in various years. After eliminating missing data for MPI analyses in 2001 to 2008, the final samples of hospitals are presented in Table 6.3.

Table 6.3 Sample Size of Hospitals (Malmquist Productivity Index)

	Total Number of Hospitals
Public Hospitals	198
Education & Research Hospitals	2
University Hospitals	26
Private Hospitals	24
Teaching Hospitals	28
Non-Teaching Hospitals	198

Data regarding service quality and patient satisfaction indexes were obtained from the Performance Management and Quality Improvement Department of Turkish Ministry of Health (TMoH) for only the year 2008. Therefore, the 2008 data is only used for efficiency analysis in Section 7.3. Nonetheless, there is no cross-sectional comparison in this section.

Generally speaking, for-profit hospitals overemphasize the control of medical costs, and somehow this may lead them to lower the quality of care. Non-profit hospitals, conversely, primarily emphasize to fulfill the demand for public goods or meeting health care needs (Lee et al., 2009). Since organizational objectives, patient selection and case-mix differences differ as a result of profit gaining; it would be unfair to compare profit and non-profit hospitals in the same sample. Therefore, to ensure greater homogeneity in performance evaluation across comparable units, we focus on examining the efficiency changes only for non-profit hospitals. Total sample is composed of 523 non-profit hospitals, but due to the missing values of some hospitals, our sample is based on the remaining 348 observations for the analysis in Section 7.3.

As Kazley and Ozcan (2009) stated hospitals may operate with different economies of scale according to their size. Especially quality and efficiency trade-off should be examined by considering hospital size. Accordingly, similar to the study of Lee et al. (2009), hospitals are grouped into peer groups based on the number of beds; as small (less than 100 beds), medium (100-199 beds), and large (200 or more beds) size facilities, in the current study.

6.2. Hospital Inputs and Outputs

The difficulties related to the selection of hospital inputs and outputs are well known and relates mainly to the nature of hospitals (Aletras et al., 2007). Hospitals are multi-product organizations; with a primary aim of improving the health outcomes for the patients they treat (Vitikainen et al., 2009). Since human factor is the most crucial issue in health care institutions, outputs do not consist of a tangible product on hand (Ozcan, 2009). Therefore in health care institutions it becomes even more complex and difficult to identify inputs and outputs accurately.

Prior research on health care efficiency has used several variables of hospital inputs and outputs. To date, there is no statistical technique to unambiguously determine inputs and outputs for analyzing efficiency using DEA (Chang et al., 2004). Notwithstanding, Valdmanis (1992) researched the sensitivity and robustness of DEA technique. Valdmanis (1992) analyzed the efficiencies of profit and public hospitals of Michigan by using different input and output sets. Valdmanis (1992) noted that public hospitals were consistently more efficient, regardless of the selection of inputs and outputs. Therefore, He concluded that DEA is a robust technique in terms of the selection of inputs and outputs according to his analysis.

Consequently, the selection of the variables to be included in the model is critical for efficiency analysis. A literature review, the above mentioned survey and the availability of data have guided the selection of inputs and outputs used in the analysis. Therefore appropriate hospital input and output variables which have been widely used in previous studies were selected for efficiency analysis (e.g. Butler and Li, 2005; Chang et al., 2004; Katharaki, 2008; Pilyavsky et al., 2006; Valdmanis et al., 2008; Weng et al., 2009).

Harrison and Ogniewski (2005) defined input variables as "*resources or environmental factors that have a strong effect on how resources are consumed by the organization*" and also he define outputs as "*factors that describe the amount of goods, services or other outcomes obtained as a result of the processing of the organization's resources*". In our analysis, we focus on technical efficiency which refers to the optimal use of resources in the production process. However, the selection of inputs and outputs might affect the efficiencies of hospitals (Valdmanis et al., 2008). Being mindful of this concern, three inputs and seven outputs are decided to use for this study. The numbers of physicians represent the human capital of hospitals. Since personnel costs represent a significant proportion of hospital operating costs, human capital is a key factor in health care decision-making process (Garcia-Lacalle and Martin, 2010). On the other hand, as Aletras et al. (2007) stated, hospital beds represent the hospital capital. According to above mentioned discussion and given constraints, following input variables chosen for the analysis are:

(1) total number of hospital beds (THB)

(2) number of specialist physicians (NOSP)

(3) *number of non-specialist physicians (NONSP)*

In the health care sphere, the difficulties of measuring health outcomes such as the degree of treatment, makes the evaluation of efficiency a controversial topic, therefore, health outcomes are usually replaced by output data (Linna et al., 2006). Hollingsworth (2008) summarized the intermediate outputs and case-mix adjusted outputs that were used in the past studies. Case-mix adjusted outputs are not included in this study because of the unavailability of data. Instead, intermediate outputs are used to describe the individual hospital outcomes in the current study.

As Blank and Valdmanis (2010) noted, the main objective of hospitals is patient care, and therefore, number of patients (inpatient and outpatient) and number of discharge are used as output variables. Also, the speed of treatment can be examined by using bed utilization rate and bed turnover rate. Thus, intermediate outputs are used to describe the individual hospital outcomes. In this paper, case-mix adjusted outputs are not included as variables because of the unavailability of data. Thus, the output variables used in this study consist of the following items:

(1) bed utilization rate (BUR)

(2) bed turnover rate (BTR)

(3) total surgical operations (TSO)

(4) number of births (NOB)

(5) total outpatient visits (TOV)

(6) average facility inpatient days (AFID)

(7) *number of discharge (NOD)*

Besides, as Dyson et al. (2001) argued, the number of DMUs has to be at least two times larger than the sum of the number of inputs and outputs. In the current study, the numbers of DMUs are over to this constraint for all the study years.

On the other hand, in order to analyze the efficiency differences between teaching and non-teaching hospitals performed in the Section 7.2., capacity and the utilization of capacity is used as inputs and outputs, respectively, In particular, physical capacity and medical labor capacity are selected as input variables. The following production items are used to evaluate the physical capacity and medical labor capacity:

Physical capacity

- total hospital beds (THB)

Medical labor capacity

- number of specialist physicians (NOSP)
- number of non-specialist physicians (NONSP)

Butler and Li (2005) argued that number of beds provides a relative investment in the facility, excluding technological investment. In parallel with this, Katharaki (2008) used the number of beds as an input in order to measure hospital size and capacity. Accordingly, physical capacity of hospital is measured by the total hospital beds while numbers of specialist and non-specialist physicians are used to measure the medical labor capacity.

Output items that describe the utilization of physical, technological and institution capacity are as follows:

Utilization of physical capacity

- bed utilization rate (BUR)
- bed turnover rate (BTR)

Utilization of technological capacity

- total surgical operations (TSO)
- number of births (NOB)

Utilization of institution capacity

- total outpatient visits (TOV)
- average facility inpatient days (AFID)
- number of discharge (NOD)

Katharaki (2008) and Chang et al. (2004) similarly used the number of beds as a criterion for hospital capacity. Accordingly utilization of physical capacity should be assessed by the utilization of hospital beds. Here, the bed turnover rate that provides a usage frequency of hospital beds was added. Bed utilization rate and bed turnover rate were selected for criteria of the utilization of physical capacity. Besides, Butler and Li (2005) concluded that surgeries require different combinations of specialized and technological equipment and staff. Therefore the utilization of technological capacity was decided to assess with regarding to total surgical operations and number of births.

Although only cesarean section entails surgery, each type of births need technological equipment and staff. Thus, births are directly related with surgeries in terms of the utilization of technological capacity.

Butler and Li (2005) also argued that total facility inpatient days measure the utilization of the institution capacity for patients using inpatient facilities. Two items, namely, total outpatient visits and number of discharge, was added in order to measure the utilization of the institution capacity for patient so that we can assess the whole institution capacity for both inpatient and outpatients. In summary, institution capacity is used to assess patient related properties of hospital. On the other hand, technological capacity is used to determine the technological resources of hospitals while physical capacity is directly related with physical resources.

Descriptive statistics of inputs and outputs used in our analysis for 2001 to 2008 are presented in Table 6.4.

Table 6.4. Descriptive Statistics of Inputs and Outputs

	Mean	Std. Dev.	Min	Max
Inputs				
total hospital beds	125.33	75.99	42.44	214.26
number of specialist physicians	36.55	15.96	17.80	55.99
number of non-specialist physicians	23.21	20.91	2.58	47.75
Outputs				
bed utilization rate	46.96	11.96	25.80	70.79
bed turnover rate	59.98	28.09	40.42	128.44
total surgical operations	1063.16	595.34	374.60	2298.61
number of births	760.50	337.12	310.51	1222.60
total outpatient visits	150759.03	121080.30	19617.75	348256.60
average facility inpatient days	3.36	1.32	1.81	4.86
number of discharge	6078.61	2758.75	2458.82	10113.63

6.3. Service Quality Index

Service quality index used in this study are provided by TMoH for the year 2008. Service Quality Index is composed of 383 service quality standards involving the physical and technical perspective of service procedures provided in a hospital. The standards including all processes beginning from a patient's application to the hospital and ended in recovery or decease. The investigation processes include both service provision to the patient and support service part. Service quality standards include the requirements for making arrangements in patient rooms, intensive care units, operation rooms, laboratories, dialysis department and other departments in the hospital. At the same time, information management specifications that determining the service planning, are included in the service quality standard.

Standards also include the sub-standards for infection control and patient and personnel safety, which are the most important parts of health care service provision. Provincial Performance and Quality Coordination Offices of TMoH investigate the hospitals affiliated to the ministry according to the service quality standards in every 4 months. The investigation processes include both service provision to the patient and support service part (Aydın et al., 2009)

In this context, service quality assessment is considered as multidimensional (Façanha and Resende, 2004) and is discussed in the literature with its two distinct concepts (Grönroos, 2000), namely, technical perspective and functional (how the service is provided) perspective. Service quality measurement of Turkish hospitals captures these perspectives with a comprehensive structure. The service quality index of individual hospitals is formed by the valid investigation results. Detailed information about Service Quality Standards and Satisfaction Surveys, described in the following section, as well as their implementation principles can be found in the study of Aydın et al. (2009).

6.4. Patient Satisfaction Index

Patient satisfaction index used in this study are provided by TMoH for the year 2008. Within the framework of Turkish Ministry of Health's "patient centered" health care service provision policies based on patient satisfaction, "Patient Satisfaction Surveys" are conducted for assessing the health care services provided from the viewpoint of patients. From the patient satisfaction perspective, two survey sets and survey implementation principles had been designated for inpatients and outpatients in order to establish patient satisfaction index. The surveys include the patients and patient families within the process.

The objective is to identify what the public opinion and how the health care results are perceived by the patients. The satisfaction measurement is carried out regularly, once in a month; however the results are evaluated one in every four months. These studies shall be carried out by the hospitals under the responsibility of the performance and quality unit. Patient satisfaction index is established by assessing the inpatient and outpatient survey results (Aydın et al., 2009).

7. EMPIRICAL ANALYSIS

7.1. Relationship between Hospital Ownership and Efficiency

7.1.1. Introduction

The aim of this section is to investigate the efficiencies of hospitals in Turkey with respect to their functional ownerships (i.e. public, education & research, university and private). The impact of health care reforms on the efficiencies is briefly examined in order to highlight possible policy implications for policy makers. The detailed discussion of the impact of health care reforms on hospital efficiency is presented in the Section 7.4. Comparative performance evaluation of hospitals has been achieved by using Data Envelopment Analysis (DEA) as well as Malmquist Productivity Index calculations (i.e. to determine the direction and degree of yearly changes in performance), super efficiency analysis and slack evaluations. According to the findings, hospital ownership significantly influences hospital efficiencies. The influence of health care reforms on hospital efficiency has been observed especially for the public and private hospitals. The average efficiencies of public hospitals remarkably increase while the average efficiencies of private hospitals decrease especially after the starting of reforms. This section adds value to the current body of research by addressing the impact of hospital ownerships and health care reforms on the efficiencies of Turkish hospitals.

7.1.2. Operational Efficiencies of Hospitals

Two assumptions of DEA, Constant Return to Scale (CRS) and Variable Return to Scale (VRS), were used to analyze the efficiencies of hospitals. Hospital efficiencies were evaluated in two different ways. Firstly hospitals were evaluated in their own groups. Secondly, all the hospitals were evaluated in the same data set. Mean, standard deviation, and minimum value of the efficiency scores and the number of efficient hospitals for each hospital types are given in the Table 7.1, Table 7.2, Table 7.3 and Table 7.4 with the assumptions of CRS and VRS in the period 2001 to 2008. The average efficiencies statistics of the hospitals in the study period are also given in Table 7.5.

Under CRS assumption, university hospitals have the minimum average efficiency score (0.30) when all hospital groups are evaluated together. However, when university hospitals are evaluated in their own group, the efficiency score increase to the 0.84. Similarly the average efficiency score of the education & research hospitals is 0.91 when isolated from other hospital groups, but it decreases to 0.49 when all the hospital groups are evaluated together.

The difference between the efficiency scores under the assumptions of CRS and VRS is caused from the differences of the scale efficiency. CRS efficiency scores of the education & research and the university hospitals are significantly less than the corresponding VRS efficiency scores. Thus, scale efficiencies of these hospitals are less than the scale efficiencies of public and private hospitals. In other words, the changes in inputs will have a relatively small effect on the outputs in the education research and university hospitals.

All hospitals are compared to the hospital(s) which performed in the most efficient scale in the CRS assumption. On the other hand, in VRS assumption any hospital k is compared to the %100 technical efficient hospitals (but not necessarily 100% scale-efficient) (Brown and Pagan, 2006). Therefore, VRS efficiency score is always equal or more than CRS efficiency score. Education & research and the university hospitals have been found less efficient than the public and private hospitals under the evaluation of scale efficiency.

Table 7.1 Efficiency Statistics of Public Hospitals

		CRS				VRS			
		Mean	Std.Dev.	Min.	# of Efficient Hospitals	Mean	Std.Dev.	Min.	# of Efficient Hospitals
2001	Public Hospitals	0.70	0.19	0.19	49	0.77	0.18	0.2	94
	All Hospitals	0.66	0.19	0.17	36	0.73	0.19	0.17	74
2002	Public Hospitals	0.71	0.19	0.25	63	0.76	0.32	0.27	93
	All Hospitals	0.66	0.19	0.25	38	0.73	0.19	0.27	73
2003	Public Hospitals	0.73	0.18	0.27	53	0.75	0.18	0.27	80
	All Hospitals	0.65	0.18	0.26	38	0.71	0.19	0.26	67
2004	Public Hospitals	0.70	0.17	0.26	47	0.77	0.17	0.26	89
	All Hospitals	0.66	0.16	0.26	33	0.74	0.17	0.26	67
2005	Public Hospitals	0.68	0.18	0.21	40	0.73	0.19	0.22	78
	All Hospitals	0.61	0.17	0.21	27	0.69	0.19	0.22	53
2006	Public Hospitals	0.75	0.17	0.22	64	0.81	0.16	0.22	104
	All Hospitals	0.70	0.16	0.18	36	0.77	0.17	0.18	67
2007	Public Hospitals	0.75	0.18	0.33	65	0.80	0.18	0.34	103
	All Hospitals	0.58	0.18	0.25	18	0.73	0.19	0.29	64
2008	Public Hospitals	0.75	0.16	0.34	59	0.83	0.15	0.42	131
	All Hospitals	0.63	0.16	0.13	22	0.75	0.17	0.37	69

Table 7.2. Efficiency Statistics of Education and Research Hospitals

		CRS				VRS			
		Mean	Std.Dev.	Min.	# of Efficient Hospitals	Mean	Std.Dev.	Min.	# of Efficient Hospitals
2001	Education &Research H.	0.93	0.9	0.75	6	1	0	1	11
	All Hospitals	0.5	0.21	0.32	1	0.73	0.19	0.52	3
2002	Education &Research H.	0.89	0.12	0.67	6	1	0	1	12
	All Hospitals	0.45	0.25	0.26	1	0.73	0.18	0.48	3
2003	Education &Research H.	0.93	0.08	0.83	5	1	0	1	9
	All Hospitals	0.44	0.17	0.28	0	0.84	0.15	0.54	3
2004	Education &Research H.	0.98	0.04	0.85	8	1	0	1	10
	All Hospitals	0.51	0.27	0.23	0	0.77	0.38	0.33	2
2005	Education &Research H.	0.85	0.16	0.55	12	0.94	0.1	0.57	20
	All Hospitals	0.53	0.23	0.23	3	0.85	0.18	0.32	14
2006	Education &Research H.	0.95	0.07	0.75	18	0.99	0.01	0.9	23
	All Hospitals	0.6	0.24	0.19	3	0.84	0.23	0.2	11
2007	Education &Research H.	0.86	0.17	0.34	12	0.96	0.1	0.59	22
	All Hospitals	0.5	0.2	0.12	2	0.9	0.19	0.17	15
2008	Education &Research H.	0.93	0.11	0.57	15	0.97	0.07	0.67	19
	All Hospitals	0.46	0.13	0.26	0	0.9	0.15	0.58	13

Table 7.3. Efficiency Statistics of University Hospitals

		CRS				VRS			
		Mean	Std.Dev.	Min.	# of Efficient Hospitals	Mean	Std.Dev.	Min.	# of Efficient Hospitals
2001	University Hospitals	0.91	0.13	0.49	18	0.99	0.02	0.98	31
	All Hospitals	0.36	0.14	0.16	1	0.74	0.19	0.26	10
2002	University Hospitals	0.88	0.15	0.53	17	0.97	0.06	0.7	28
	All Hospitals	0.3	0.11	0.15	0	0.73	0.22	0.28	11
2003	University Hospitals	0.83	0.16	0.4	12	0.97	0.07	0.64	34
	All Hospitals	0.38	0.16	0.16	1	0.88	0.18	0.37	25
2004	University Hospitals	0.82	0.19	0.31	14	0.96	0.1	0.54	31
	All Hospitals	0.34	0.15	0.12	1	0.69	0.24	0.3	13
2005	University Hospitals	0.81	0.17	0.41	12	0.94	0.1	0.61	26
	All Hospitals	0.27	0.12	0.12	0	0.75	0.21	0.33	14
2006	University Hospitals	0.84	0.18	0.31	15	0.94	0.09	0.66	32
	All Hospitals	0.3	0.12	0.08	0	0.6	0.28	0.14	10
2007	University Hospitals	0.82	0.19	0.31	15	0.97	0.06	0.7	34
	All Hospitals	0.27	0.17	0.07	1	0.83	0.22	0.22	18
2008	University Hospitals	0.88	0.13	0.44	13	0.99	0.01	0.94	33
	All Hospitals	0.22	0.14	0.1	1	0.49	0.25	0.14	5

Table 7.4. Efficiency Statistics of Private Hospitals

		CRS				VRS			
		Mean	Std.Dev.	Min.	# of Efficient Hospitals	Mean	Std.Dev.	Min.	# of Efficient Hospitals
2001	Private Hospitals	0.69	0.23	0.24	15	0.78	0.23	0.28	27
	All Hospitals	0.57	0.26	0.15	11	0.63	0.24	0.19	13
2002	Private Hospitals	0.69	0.23	0.27	18	0.77	0.22	0.29	30
	All Hospitals	0.56	0.23	0.16	9	0.64	0.22	0.19	14
2003	Private Hospitals	0.72	0.23	0.27	27	0.78	0.22	0.29	36
	All Hospitals	0.63	0.26	0.16	22	0.69	0.24	0.23	24
2004	Private Hospitals	0.67	0.23	0.26	22	0.77	0.21	0.31	41
	All Hospitals	0.61	0.24	0.19	19	0.72	0.21	0.28	32
2005	Private Hospitals	0.66	0.21	0.24	24	0.71	0.21	0.25	41
	All Hospitals	0.57	0.23	0.2	14	0.65	0.23	0.21	26
2006	Private Hospitals	0.61	0.25	0.11	31	0.72	0.22	0.27	52
	All Hospitals	0.59	0.26	0.11	31	0.68	0.23	0.26	44
2007	Private Hospitals	0.62	0.24	0.12	45	0.7	0.25	0.18	88
	All Hospitals	0.61	0.25	0.12	43	0.68	0.25	0.17	77
2008	Private Hospitals	0.61	0.24	0.11	40	0.72	0.22	0.13	79
	All Hospitals	0.59	0.24	0.07	32	0.67	0.23	0.12	58

Table 7.5. Average Efficiency Statistics of the Hospitals

		Constant Return to Scale (CRS)				Variable Return to Scale (VRS)			
		Mean	Std.Dev.	Min.	# of Efficient Hospitals	Mean	Std.Dev.	Min.	# of Efficient Hospitals
Public Hospitals	Public Hospitals	0.71	0.17	0.25	55	0.77	0.19	0.27	96.50
	All Hospitals	0.64	0.17	0.21	31	0.73	0.18	0.25	66.75
Education and Research Hospitals	Ed & Res. Hospitals	0.91	0.20	0.66	10.25	0.98	0.03	0.84	15.75
	All Hospitals	0.49	0.21	0.23	1.25	0.82	0.20	0.39	8
University Hospitals	University Hospitals	0.84	0.16	0.40	14.5	0.96	0.06	0.72	31.12
	All Hospitals	0.30	0.13	0.12	0.62	0.71	0.22	0.25	13.25
Private Hospitals	Private Hospitals	0.66	0.23	0.20	27.75	0.74	0.22	0.25	49.25
	All Hospitals	0.59	0.24	0.14	22.62	0.67	0.23	0.20	36

7.1.3. Relationship between Hospital Ownership and Efficiency Score

Statistically differences between the efficiencies of the four groups of hospitals were analyzed by using Kruskal-Wallis test. Results are shown in Table 7.6. According to the findings, hospital efficiencies significantly differentiate with respect to the hospital ownership criteria in all the study years.

Table 7.6. Test Results for the Differences of Hospital Efficiencies by Ownership

Years	Ki-Square	Degree of Freedom
2001	40.365*	3
2002	38.980*	3
2003	36.123*	3
2004	33.779*	3
2005	30.703*	3
2006	47.439*	3
2007	41.254*	3
2008	39.782*	3

* Significant at $p < 0.01$

It is reasonable to say that education research and university hospitals have a completely different structure from the public and private hospitals since they are more oriented towards scientific development and training. Public hospitals and private hospitals were also shown to be different in terms of their efficiencies. Our findings in Table 7.6 are in line with the results of the previous studies. In addition, average efficiencies of public hospitals are higher than the private hospitals.

7.1.4. Super Efficiency Analysis

All 100% efficient DMUs will be called efficient in DEA. However it may not be argued that the efficiencies of all efficient DMUs are the same. Ranking among these efficient hospitals can be made by using the super-efficiency score (Zhu, 2003).

According to the analyses public and private hospitals have been found high efficiency level in the ranking of super efficient hospitals. On the other hand, most of the education-research and university hospitals are in the bottom side of the ranking.

7.1.5. Patterns of Efficiency Changes

Efficiency changes of hospitals are evaluated by using Malmquist Productivity Index. If MPI exceeds unity there has been an improvement in productivity between periods T0 and T1. Only the hospitals which are in data set for all the study periods can be analyzed by MPI technique. Therefore some hospitals were eliminated from the data. The remaining 198 public hospitals, 2 education-research hospitals, 26 university hospitals and 24 private hospitals were analyzed.

Yearly MPI statistics of four groups of hospitals are shown in Table 7.7. The body of the table shows how many hospitals' MPI values exceed 1 (>1), how many equal 1 (=1), and how many is below 1 (<1). It is interesting that public hospitals' MPI measures seriously increase after the year 2004. In accordance with this result, technical efficiencies of public hospitals markedly increased for this period.

Table 7.7. MPI Statistics for Hospitals

		Number of Hospitals						
	MPI	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008
Public Hospitals	> 1	89	86	158	118	105	154	105
	= 1	14	12	9	18	11	3	13
	< 1	95	100	31	62	82	41	80
Education and Research Hospitals	> 1	1	1	2	0	2	1	0
	= 1	0	0	0	1	0	0	0
	< 1	1	1	0	1	0	1	2
University Hospitals	> 1	16	15	20	15	16	3	15
	= 1	0	0	0	9	0	1	1
	< 1	10	11	6	2	10	22	10
Private Hospitals	> 1	11	9	10	10	12	8	15
	= 1	6	6	6	7	5	3	7
	< 1	7	9	8	7	7	13	2

Increased efficiency of public hospitals in this period might be correlated with the health care reforms. Turkish Ministry of Health started hospital performance reforms in 2004 (Aydın and Demir, 2006). As can be seen from the average efficiency values in Table 7.4., the average efficiency of private hospitals clearly decreases in 2004. According to the MPI values in Table 7.7, there is a serious alteration in the efficiencies of public hospitals and private hospitals after 2004. In addition, Wilcoxon test is applied to evaluate the significant differences between the hospital efficiencies for these years. Test statistics are presented in the Table 5.

Table 7.8. Significant Differences between Hospital Efficiencies

Years	Z Statistics
2001-2002	-1.457
2002-2003	-2.282**
2003-2004	-4.192***
2004-2005	-0.188
2005-2006	-0.481
2006-2007	-0.374
2007-2008	-1.246

* significant at 0,1 level; ** significant at 0,05 level; *** significant at 0,001 level

According to the findings it can be shown that there is a significant difference between the hospital efficiencies. The degree of significant differences is higher in 2003 and 2004. Consequently it can be argued that health care reforms which have started in 2004 might have an effect on hospital efficiencies, especially for the public and private hospitals. Possible reasons of this finding are discussed in the Section 7.4.

7.1.6. Inefficiency Analysis

Inefficiency is caused by non-effective use of the inputs and/or outputs (Cooper et al., 2004). Therefore evaluation of the slack for inputs and outputs is crucial for efficiency improvement. Inefficiency statistics of each group of hospitals are shown in Table 7.9, Table 7.10, Table 7.11, Table 7.12 and Table 7.13.

Slack values show that number of medical practitioners should be decreased for education & research hospitals and university hospitals. On the output side, outpatient number should be increased for all groups of hospitals. Outpatient number seems awfully insufficient for university hospitals. However outpatient number does not show that much slack for education & research hospitals. Managers of university hospitals should investigate the causes of this inefficiency. In addition, education & research hospitals can be a role model for university hospitals in terms of outpatient slack. The slack of discharge number is nearly same for the public and private hospitals thereby the improvement actions for increasing discharge numbers might be similar between these hospitals.

The evaluation of the slacks is shown that improvement activities should be implemented for all groups of hospitals. According to the findings public and private hospitals have the similar slack values for inputs and outputs while education & research and university hospitals have similar slacks. Hospital managers attend to this case for the planning of improvement activities.

Table 7.9. Slack Evaluations of Public Hospitals

	Inputs			Outputs						
	THB	NOSP	NONSP	TOV	NOD	TSO	NOB	BUR	AFID	BTR
2001	0.34	0.01	1.32	5274.29	476.73	72.34	592.97	41.72	1.34	1.84
2002	0.38	0.03	1.05	20474.35	129.80	57.38	473.98	46.544	0.88	1.75
2003	0.99	0.10	0.88	54447.10	92.86	92.91	486.11	65.06	2.14	1.01
2004	0.51	0.06	1.03	11230.92	335.38	156.64	988.02	73.72	1.81	2.85
2005	0.42	0.01	0.11	33889.02	269.14	155.44	463.48	121.74	4.02	2.30
2006	1.04	0.10	0.49	9969.50	671.17	261.61	252.34	62.53	1.89	1.70
2007	1.10	0.65	0.03	16643.54	394.22	183.35	438.54	29.58	0.78	0.52
2008	0	0.53	0.64	26750.83	179.37	134.60	390.09	35.12	1.38	1.39

THB: total hospital beds; NOSP: number of specialist physicians; NONSP: number of non-specialist physicians; TOV: total outpatient visits; NOD: number of discharge; TSO: total surgical operations; NOB: number of births; BUR: bed utilization rate; AFID: average facility inpatient days; BTR: bed turnover rate.

Table 7.10. Slack Evaluations of Education and Research Hospitals

	Inputs			Outputs						
	THB	NOSP	NONSP	TOV	NOD	TSO	NOB	BUR	AFID	BTR
2001	15.17	0	37.51	30364.86	1265.47	1451.91	2446.43	25.12	0.85	3.38
2002	87.29	0.34	47.26	2340.82	1003.03	2897.41	7208.33	56.94	0.43	18.36
2003	0	0	3.98	231350	923.78	4063.32	1368.95	38.47	1.60	0.44
2004	24.80	0	21.03	116121.10	1497.13	1772.11	637.60	15.96	0	0.70
2005	66.87	4.41	28.77	246389.60	3397.03	1116.03	6717.58	101.33	2.56	4.01
2006	6.01	0	42.41	58727.43	3588.94	4242.33	4939.59	35.15	1.22	5.66
2007	15.51	3.47	60.40	80776.71	4070.78	3747.09	7072.34	68.34	1.53	5.22
2008	3.35	3.20	74.78	164641.70	258.73	5367.93	1753.14	50.65	1.87	0.88

THB: total hospital beds; NOSP: number of specialist physicians; NONSP: number of non-specialist physicians; TOV: total outpatient visits; NOD: number of discharge; TSO: total surgical operations; NOB: number of births; BUR: bed utilization rate; AFID: average facility inpatient days; BTR: bed turnover rate.

Table 7.11. Slack Evaluations of University Hospitals

	Inputs			Outputs							
	THB	NOSP	NONSP	TOV	NOD	TSO	NOB	BUR	AFID	BTR
2001	5.93	0	29.36	158925.00	1933.21	248.10	358.07	72.49	4.25	4.67
2002	21.87	0.40	35.66	85191.45	1634.08	419.57	612.14	45.88	0.99	3.31
2003	35.94	1.47	78.64	145618.30	2157.98	531.36	258.96	34.14	0.07	1.71
2004	27.39	0.33	86.88	151207.80	3480.91	1185.12	231.14	39.97	0.26	2.15
2005	51.8	0.19	102.38	173938.60	5435.24	1506.52	192.44	60.24	0.41	3.91
2006	28.28	0	70.75	126836.00	1619.46	858.40	560.03	122.58	2.91	7.04
2007	2.17	0.29	71.69	130452.40	447.26	3929.95	1535.45	159.85	4.33	11.14
2008	52.49	5.94	34.34	72296.47	2072.76	6584.37	895.57	83.69	2.47	6.02

THB: total hospital beds; NOSP: number of specialist physicians; NONSP: number of non-specialist physicians; TOV: total outpatient visits; NOD: number of discharge; TSO: total surgical operations; NOB: number of births; BUR: bed utilization rate; AFID: average facility inpatient days; BTR: bed turnover rate.

Table 7.12. Slack Evaluations of Private Hospitals

	Inputs			Outputs						
	THB	NOSP	NONSP	TOV	NOD	TSO	NOB	BUR	AFID	BTR
2001	1.28	0.47	0.79	2406.06	549.60	109.03	330.52	28.68	0.18	27.68
2002	1.89	0.17	0.72	1860.79	479.79	216.51	925.65	27.15	0.20	2702.06
2003	1.21	0.37	0.96	3398.57	299.0	136.13	574.02	15.45	0.07	6.03
2004	3.51	0.44	0.71	9200.12	476.27	179.63	105.20	41.27	0.29	16.37
2005	1.67	0.01	0.18	2934.02	269.12	274.14	377.68	23.18	0.12	16.29
2006	0.63	0.09	0.26	3217.83	403.81	147.55	193.23	22.50	0.06	6.82
2007	0.01	0.91	0.34	11639.51	261.16	246.05	500.97	38.54	0.29	8.25
2008	3.35	0.35	0.51	3282.39	354.39	248.16	495.68	11.50	0.05	9.41

THB: total hospital beds; NOSP: number of specialist physicians; NONSP: number of non-specialist physicians; TOV: total outpatient visits; NOD: number of discharge; TSO: total surgical operations; NOB: number of births; BUR: bed utilization rate; AFID: average facility inpatient days; BTR: bed turnover rate.

Table 7.13. Slack Evaluations of All Hospitals

	Inputs			Outputs						
	THB	NOSP	NONSP	TOV	NOD	TSO	NOB	BUR	AFID	BTR
2001	0.53	0.01	9.38	2526.61	326.80	53.23	793.61	56.16	1.68	25.50
2002	0.15	0.06	6.39	4770.92	223.46	145.95	845.74	82.16	1.71	2510.88
2003	1.08	0.11	9.29	8748.03	151.24	185.41	848.36	66.03	1.44	10.50
2004	1.99	0.07	6.19	8335.19	494.65	155.58	542.07	97.99	1.74	29.61
2005	1.32	0.04	4.54	9649.85	448.31	272.47	718.04	88.84	1.62	35.97
2006	0.85	0.02	5.84	6047.73	475.11	207.85	411.54	68.48	1.54	15.03
2007	0.01	0.39	2.33	19507.39	540.92	446.15	796.57	98.54	1.51	16.24
2008	0.31	0.17	4.66	6550.19	700.49	243.68	739.27	39.30	1.14	7.08

THB: total hospital beds; NOSP: number of specialist physicians; NONSP: number of non-specialist physicians; TOV: total outpatient visits; NOD: number of discharge; TSO: total surgical operations; NOB: number of births; BUR: bed utilization rate; AFID: average facility inpatient days; BTR: bed turnover rate.

7.1.7. Discussion

In this section, the comparative efficiencies of hospitals have been assessed using Data Envelopment Analysis. Three inputs and ten outputs have been used in the analysis. Changes in efficiencies of the hospitals over the period 2001-2008 have been analyzed using the Malmquist Productivity Index technique. The results confirmed the expectations concerning the impact of health care reforms on the hospital efficiency.

As discussed in the introduction, the theoretical literature contains several, sometimes conflicting, suggestions that efficiency may differ across ownership types of hospitals. Empirical evidence was found about diversity between the ownership types of hospitals according to their efficiencies. It can be said, as an example, that if all the resources of any public hospital put in the place of, say, a private hospital, the degree of efficiency will be changed. This will also be true among other types of hospital ownerships.

The impact of health care reforms on the hospital efficiency was also investigated. Health care reforms have been started in 2004 and these are still going on. According to the findings, these reforms are mostly influenced on the public and private hospitals. Average efficiencies of public hospitals remarkably increased while the average efficiencies of private hospitals decreased after the year 2004.

Another interesting finding in this research was that, contrary to the expectations, most of the highly efficient hospitals were from the small cities (in terms of population). As usual there are more hospitals in the big cities. However this study showed that there is no relationship between the city population and the hospital efficiencies.

Finally, too many hospitals were found inefficient. This means there is considerable room for improvement activities. According to the findings, hospital ownership will have to be crucial role in these improvement activities. Therefore, hospital managers and policy makers should take into account the basic grounds of efficiency under each type of hospital ownerships.

7.2. Inefficiency Analysis of Teaching and Non-Teaching Hospitals

7.2.1. Introduction

This section investigates capacity-based inefficiency causes and the existence of any differences between the improvement processes of teaching and non-teaching hospitals. In an effort to comparatively evaluate the inefficiency causes of hospitals in Turkey, this study uses data envelopment analysis (DEA). DEA can simultaneously assess the relationship between capacity (physical capacity and medical labor capacity) as inputs and the utilization of capacity (utilization of the institution capacity for patients, utilization of the physical capacity and utilization of technological capacity) as outputs. In addition Malmquist Productivity Index (MPI) is used to analyze the patterns of efficiency change for the study years. Several improvement suggestions have been provided to the health care policy makers regarding the inefficiency causes and the ways to optimize hospital efficiency.

7.2.2. Operating Efficiencies of Teaching and Non-teaching Hospitals

In this section, teaching and non-teaching hospitals are evaluated separately in order to examine inefficiencies of hospitals in the period of 2001 to 2008. As Chang et al. (2010) argued, to ensure greater homogeneity in efficiency analysis across comparable units, and taking into account sample size variations, efficiencies of teaching and non-teaching hospitals are evaluated separately Thereby, hospitals are benchmarked in their peer groups by separately analyzing the efficiencies. Although choosing separately efficiency analysis, teaching and non-teaching hospitals are characterized by the same processes in order to provide comparatively inefficiency results.

DEA is used to analyze technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE) of hospitals. By analyzing the relationship between TE and PTE scores, most productive scale size (MPSS) is evaluated. MPSS is measured as the ratio of the number of MPSS hospitals to the number of all hospitals for both teaching and non-teaching hospitals. Specifically, CRS score captures global (technical) efficiency, whereas the VRS and scale scores decompose the global score into pure technical efficiency and scale efficiency, respectively (Ancarani et al., 2009). Therefore evaluating the MPSS ratio allows identifying weather decision units operate at optimal scale or not.

In the present paper contemporaneous frontier analysis is used to examine separate efficiencies of teaching and non-teaching hospitals for each year. Average efficiencies of hospitals could be clearly examined by using contemporaneous frontier analysis. Thereby yearly efficiency changes could be evaluated. Efficiency statistics of hospitals to the periods of 2001 to 2008 are presented in Table 7.14.

As shown in Table 7.14, teaching hospitals have higher levels of technical and pure technical efficiencies than non-teaching hospitals with exceptions of the technical efficiencies of teaching hospitals in 2007 and 2008. Conversely, scale efficiencies of non-teaching hospitals are higher than teaching hospitals. These findings suggest that the changes in inputs will have a relatively small effect on the outputs for teaching hospitals. Another incidental finding is regarding to the MPSS ratios of teaching and non-teaching hospitals. According to the MPSS ratios, teaching hospitals (min: 25.37; max: 39.65) operate at more optimal scale or optimal size than non-teaching hospitals (min: 14.85; max: 19.44).

Table 7.14. Efficiency statistics of teaching and non-teaching hospitals

		Technical Efficiencies*	Pure Technical Efficiencies*	Scale Efficiencies*	MPSS Ratios
Teaching Hospitals	2001 (n=47)	0.82	0.97	0.84	29.78
	2002 (n=48)	0.81	0.93	0.87	31.25
	2003 (n=49)	0.82	0.96	0.85	34.69
	2004 (n=50)	0.81	0.95	0.85	32.00
	2005 (n=67)	0.73	0.90	0.80	28.35
	2006 (n=65)	0.77	0.93	0.81	33.84
	2007 (n=67)	0.73	0.96	0.76	25.37
	2008 (n=58)	0.73	0.96	0.76	39.65
Non-Teaching Hospitals	2001 (n=362)	0.72	0.79	0.91	16.29
	2002 (n=372)	0.73	0.77	0.94	19.35
	2003 (n=375)	0.71	0.76	0.93	16.80
	2004 (n=398)	0.73	0.79	0.92	15.07
	2005 (n=350)	0.70	0.76	0.91	14.85
	2006 (n=360)	0.76	0.83	0.91	19.44
	2007 (n=352)	0.75	0.80	0.93	18.75
	2008 (n=365)	0.75	0.83	0.90	16.16

* Average efficiency scores

It is pointed out here that there are differences between the efficiencies of teaching and non-teaching hospitals in terms of the efficiency scores. In order to determine whether the differences of technical efficiency scores are statistically significant between teaching and non-teaching hospitals, we conducted a Kruskal-Wallis test (Chang et al., 2004). The null hypothesis being tested is that there are no differences in terms of efficiencies between the two groups of hospitals. Chang et al. (2004) test a similar hypothesis for the Taiwan hospitals for the years 1996 and 1997. The null hypothesis of equal means is rejected at 0.001 level of statistical significance in each of the eight sample years of study.

However, this difference might be attributable to the size of the hospitals. We used total number of hospital beds for defining the size of hospitals. Hence, Kruskal-Wallis test is conducted by dividing the hospitals into two groups (less than 100 beds and more than 100 beds) to compare the efficiency differences between the hospitals in terms of a teaching function for the confirmation of the differences. Again the test confirmed the previous results. According to the analyses, it is found that the differences in efficiencies of teaching and non-teaching hospitals are statistically significant.

Moreover, average TE, PTE and SE scores of teaching hospitals tend to decrease in time while non-teaching counterparts tend to increase. The Wilcoxon test has been used to compare teaching and non-teaching hospital efficiencies relative to the study years 2001 and 2008. Average technical efficiencies of teaching hospitals (see in Table 7.14), which was 0.825 in 2001, reduced to 0.739 in 2008 ($P<0.001$). In parallel reveals a smaller yet still statistically significant reduction in average PTE scores from 0.972 to 0.961 of teaching hospitals ($P<0.001$). Moreover average SE score of teaching hospitals was 0.847 in 2001 and reduced to 0.765 in 2008 ($P<0.001$).

Non-teaching hospital efficiencies relatively increased in the period of 2001 to 2008. Average TE scores of non-teaching hospitals was 0.722 in 2001 and increased to 0.751 in 2008 ($P<0.001$). The same holds for non-teaching hospitals which demonstrate minimal increase in average PTE scores from 0.790 to 0.832 ($P<0.001$). Average SE scores of non-teaching hospitals which was 0.914 in 2001 decreased to 0.901 in 2008 ($P<0.001$). Detected findings provide the evidence that differences are statistically significant at 0.001 levels.

7.2.3. Patterns of Efficiency Changes

MPI is used to analyze the patterns of efficiency changes of teaching and non-teaching hospitals over the eight years of the study. Since this method does not require the assumption of a possibly unwarranted functional form on the production technology, as required by the econometric method, it is suitable for measuring the efficiency changes (Wu & Ho, 2007). MPI shows the efficiency changes of teaching and non-teaching hospitals for the seven periods. The first three columns of the Table 7.15 shows how many hospitals' MPI values exceed 1 (>1), how many equal 1 (=1), and how many is below 1 (<1). The average MPI scores and the standard deviations (in parenthesis) were given in the fourth column. Also minimum and maximum MPI scores were given in the last two columns. MPI analysis results are summarized in Table 7.15.

Table 7.15. Changes in Efficiencies over Time

		MPI=1[1]	MPI>1[2]	MPI<1[3]	Average MPI	Min	Max
Teaching Hospitals (n=28)	2001-2002	6 21.42*	9 32.14*	13 46.42*	1.017 (0.17)	0.66	1.62
	2002-2003	7 25*	13 46.42*	8 28.57*	1.02 (0.18)	0.61	1.68
	2003-2004	6 21.42*	7 27*	15 51.57*	0.96 (0.14)	0.61	1.26
	2004-2005	7 25*	8 28.57*	13 46.42*	0.96 (0.13)	0.66	1.30
	2005-2006	4 14.28*	7 25*	17 60.71*	0.97 (0.16)	0.67	1.44
	2006-2007	7 25*	3 10.71*	18 64.28*	0.93 (0.13)	0.68	1.35
	2007-2008	6 21.44*	4 14.28*	18 64.28*	0.98 (0.15)	0.63	1.44

Non-Teaching Hospitals (n=198)	2001-2002	20 10.10*	95 47.97*	83 41.91*	1.02 (0.16)	0.60	1.74
	2002-2003	23 11.61*	92 46.46*	83 41.91*	1.01 (0.16)	0.54	1.78
	2003-2004	24 12.12*	33 16.66*	141 71.21*	0.88 (0.17)	0.58	1.85
	2004-2005	24 12.12*	93 46.96*	81 40.9*	1.02 (0.11)	0.74	1.39
	2005-2006	24 12.12*	83 41.91*	91 45.95*	1.00 (0.27)	0.55	3.86
	2006-2007	9 4.54*	40 20.2*	149 75.25*	0.91 (0.20)	0.42	2.01
	2007-2008	13 6.56*	80 40.40*	105 53.03*	1.01 (0.19)	0.47	3.66

* Ratio of each category

Standard deviations of MPI values were given in the parenthesis

[1]: Efficiency does not change according to the previous year

[2]: Efficiency increase according to the previous year

[3]: Efficiency decrease according to the previous year

The efficiency trend of teaching hospitals has positive growth for only 2001-2002 and 2002-2003 years. However relatively large shortfall in efficiency is viewed from 2004 to 2008 for teaching hospitals. In addition, minimum and maximum MPI scores and also standard deviations of MPI values of teaching hospitals are quite similar over the time period.

As Yu and Ramanathan (2008) suggested, the geometric mean of MPI scores are calculated to analyze the trends of changes in efficiency of teaching hospitals. The geometric means of MPI scores of teaching hospitals is found 0.98. This result provides the evidence that the efficiencies of teaching hospitals have a negative trend over the time period of study. Moreover, the efficiencies of teaching hospitals decreased to 46.42 percent in the period of 2001-2002 while this ratio increased to 64.28 in the period of 2007-2008. Inefficient hospital ratio mounted the 60 percent level particularly in 2006, 2007 and 2008. Thus, efficiencies of teaching hospitals declined in recent years. These findings are consistent with the average technical and pure technical efficiency scores (see in Table 7.14) of teaching hospitals.

According to the findings, efficiency trends of non-teaching hospitals have positive growth in the periods of 2001-2002, 2002-2003, 2004-2005, 2005-2006 and 2007-2008. In addition, efficiencies of non-teaching hospitals dramatically decreased in the periods of 2003-2004 (inefficient hospital ratio is 71.21 percent) and 2006-2007 (inefficient hospital ratio is 75.25 percent). Efficiencies of non-teaching hospitals also decreased over the time period 2001 to 2008 in terms of geometric means (0.97). These MPI results are incompatible with the average efficiencies of non-teaching hospitals for which average efficiency was 0.72 in 2001 while 0.75 in 2008 (Table 7.15).

It is interesting to find this dilemma about the efficiencies of non-teaching hospitals. Then, what might be the cause(s) of differences between the average efficiency changing and the efficiency trend of non-teaching hospitals? Maximum MPI score was 3.86 in the period of 2005-2006; 2.01 in the period of 2006-2007 and 3.66 in the period of 2007-2008. In addition standard deviation of MPI values of non-teaching hospitals was 0.27 in 2005-2006; 0.20 in 2006-2007 and 0.19 in 2007-2008. Despite that, maximum MPIs and standard deviations were more nominal in the other periods for non-teaching hospitals (max MPI: 1.85 and max standard deviation: 0.17). These measures indicate that non-teaching hospitals separated to the high efficient to the low efficient frontier particularly in the recent years. Therefore high efficient non-teaching hospitals might have increased the average efficiencies while the efficiency trend decreased over the time period of 2001 to 2008.

7.2.4. Inefficiency Causes of Teaching and Non-teaching Hospitals

DEA analyzes existing inefficiency causes in order to identify slacks, that is, lack of outputs or excessive inputs for inefficient hospitals, and suggests some possible input reductions and/or output augmentations so that an inefficient unit can become efficient (Lee et al., 2009; Giokas, 2001). This allows health care administrators find out which inputs and/or outputs appear to be inefficiently used or produced (Harrison and Kirkpatrick, 2009). For this reason, DEA is a very constructive technique for health care administrators seeking to identify opportunities for efficiency improvement (Nayar and Ozcan, 2008).

The purpose here is to investigate the inefficiency causes that explain variations of overall inefficiency. Percentage change of capacities and the utilization of capacities are shown in Table 7.16 as well as the standard deviations and the minimum-maximum values as percentage. As an example percentage change of the utilization of physical capacity for teaching hospitals is calculated as following. Bed utilization rate and bed turnover rate are the criterion of utilization of physical capacity. The slack mean of bed utilization rate is 59.91 (see in Table 7.17), and the current item mean is 75.02 (see in Table 7.17) according to pooled data. Therefore bed utilization rate should be increased to 134.94 (sum of slack and current values) in order to eliminate the inefficiency. Here it can be found the percentage change of bed utilization rate, which is 79.85%. Percentage change of bed turnover rate can be found in similar manner, which is 59.46%. Therefore percentage change of utilization of physical capacity is arithmetic averages of 79.85% and 59.46%, which is 69.66%. Other dimensions are found in a similar manner.

Table 7.16. Percentage change of capacities and the utilization of capacities

		Percentage decrease of the capacity		Percentage increase of the utilization of capacity		
		Physical Capacity Excesses	Medical Labor Capacity Excesses	Utilization of Physical Capacity Shortages	Utilization of Technological Capacity Shortages	Utilization of Institution Capacity Shortages
Teaching Hospitals (n=393)	Mean	3.89	11.63	69.66	149.95	25.25
	Std. Dev.	2.53	3.73	64.27	64.17	10.99
	Min.	0.29	5.94	90.27	91.19	11.37
	Max.	8.18	15.98	283.48	277.28	43.07
Non-teaching Hospitals (n=2,569)	Mean	0.54	3.93	75.82	31.55	16.66
	Std. Dev.	0.35	2.11	43.43	9.61	8.62
	Min.	0	0.81	70.77	22.30	6.73
	Max.	0.93	6.63	188.66	25.72	31.94

The results in Table 7.16 indicate that inefficient non-teaching hospitals need fewer improvements in all their capacity inefficiencies as compared to inefficient teaching hospitals except the utilization of physical capacity. Particularly, the reduction in medical labor capacity that might be achieved is, on an average, 11.63% (standard deviations: 3.73) for teaching hospitals and 3.93% (standard deviations: 2.11) for non-teaching ones.

In addition percentage physical capacity excesses are 3.89 (standard deviations: 2.53) for teaching hospitals while 0.54 (standard deviations: 0.35) for non-teaching hospitals. The maximum percentage medical labor capacity excesses is 15.98 for teaching hospitals while 6.63 for non-teaching counterparts. In accordance maximum physical capacity excesses is 8.18 for teaching hospitals while 0.93 for non-teaching hospitals. According to these findings, there are significant differences between teaching and non-teaching hospitals in the excesses of medical labor capacity and physical capacity.

Average physical capacity inefficiency for teaching hospitals shows that significant potential savings can be obtained. Even though there is an excess in the physical capacity, medical labor capacity is the prior cause of the high average inefficiencies for teaching hospitals in the perspective of input factors. As mentioned above, in this section it is commonly used broad concept and capacity dimensions to capture hospital inputs and outputs.

Thereby inefficiency causes can be investigated by capacity perspective as analyzed in Table 7.16 and also analyzed by individual input and output inefficiencies. Slack means, current item means and target item means are analyzed for individual inputs and outputs as shown in Table 7.17. Target item mean is calculated by subtracting the slack mean from the current item mean for inputs while sum of slack mean and current item mean for outputs. As similar to above analysis, pooled data of teaching and non-teaching hospitals is used to examine average slack values of inputs and outputs.

Slack values in Table 7.17 shows that the main inefficiency cause of medical labor capacity is the excesses of number of non-specialist physicians for teaching hospitals. Possible reduction of number of non-specialist physicians that might be achieved is, on average, 21.76% for teaching hospitals while the average reduction in the number of specialist physicians is 1.50%. Particularly, the average number of non-specialist physicians could be reduced from 247.95 to 193.98. According to the inefficiency causes of non-teaching hospitals there are limited excesses with regard to the physical capacity and medical labor capacity as compared with teaching hospitals.

Table 7.17. Average slack values of inputs and outputs

	Teaching Hospitals (n=393)			Non-Teaching Hospitals (n=2569)		
	Slack Means	Current Item Means	Target Item Means	Slack Means	Current Item Means	Target Item Means
Inputs						
total hospital beds	23.27	612.05	588.27	0.72	135.15	134.42
number of specialist physicians	3.14	208.12	247.95	0.61	27.68	27.07
number of non-specialist physicians	53.97	247.95	193.98	0.68	12.05	11.36
Outputs						
bed utilization rate	59.91	75.02	134.94	51.96	51.86	103.83
bed turnover rate	4.43	7.45	11.88	1.41	2.74	4.15
total surgical operations	2194.89	5193.91	7388.8	149.33	893.43	1042.76
number of births	4751.17	1844.10	6595.28	429.01	924.58	1353.59
total outpatient visits	216901.58	424200.43	641102.01	23879.59	231350.39	255229.99
average facility inpatient days	0.89	6.92	7.81	1.48	4.29	5.77
number of discharge	2737.25	23269.85	26007.11	323.18	6233.71	6556.90

The slack values of the utilization of physical capacity indicate that there should be augmentation to the utilization of physical capacity both on the teaching and non teaching hospitals. Moreover from an output perspective, the most important inefficiency cause is the utilization of physical capacity for non-teaching hospitals. Particularly, increment in the utilization of physical capacity that should be achieved is 75.82 percentages for non-teaching hospitals and 69.66 percentages for teaching counterparts.

Inefficiencies of the utilization of physical capacity have higher impact on the overall inefficiencies of non-teaching hospitals, especially considering the inefficiency causes of non-teaching hospitals. Additionally inefficiency of the utilization of physical capacity is underemployed by more than 65% for teaching hospitals. Therefore non-effective utilization of physical capacity has to be taken into account by hospitals in order to grab at potential opportunities.

An analysis of the inefficient utilization of technological capacity shows that there is a potential for augmenting the outputs of hospitals. The increment in the utilization of technological capacity that might be achieved is, on average 149.95% for teaching hospitals and 31.55% for non-teaching ones. According to these results, there is a significant difference between teaching and non-teaching hospitals in terms of the shortages of utilization of technological capacity. In other words, teaching hospitals have enough technological resources in order to increase the existing number of surgical operations and births to more than one and half times.

In particularly, slack mean of total number of surgical operations is 2194.89 and the current item mean is 5193.91 (see in Table 5). Therefore total number of surgical operations should be increased to 7388.80 (sum of slack and current item mean) in order to eliminate inefficiency. Then percentage increment of the total number of surgical operations is 42.25%. Percentage increment of the number of births could be found in a similar manner, which is 257.64%. According to these results it can be stated that teaching hospitals should increase the existing level of the utilization of technological capacity through increasing the existing amount of surgical operations and number of births. In other words, teaching hospitals have a chance to deliver heath care to more patients through effective usage of its existing technological capacities.

Results indicate that the utilization of institution capacity for patient has the least potential for increasing the outputs. Particularly the average utilization of institution capacity could be increased by 25.25% for teaching hospitals and 16.66% for non-teaching hospitals. However this factor is directly related to the patient care, and therefore, it has a highly significant effect on hospital efficiency. From this perspective, the increase of the utilization of the institution capacity by approximately 15-25% for hospitals may be considered a crucial improvement. Furthermore total outpatient visit should be increased by 51.13 percent for teaching hospitals while 10.32 percent for non-teaching hospitals in order to eliminate inefficiencies.

7.2.5. Discussion

According to the statistical results of quantitative analyses, hospitals significantly differentiate with regard to the teaching status. Thus, health care policy makers and hospital chief officers should take into account the teaching function of hospitals while implementing process of improvement plans and reforms (Gok and Sezen, 2012).

As findings suggest, teaching hospitals show a higher level of technical and pure technical efficiencies than that of non-teaching hospitals during the seven years study period. The main reason for this difference might be the differences between the missions of teaching and non-teaching hospitals. Non-teaching hospitals tend to increase their physical capacity in order to meet the needs of their patients as their main mission of delivering health care.

On the other hand, teaching hospitals increase capacity to spend more resources on the training and re-education of their medical staff. Hence, high technology can help enhancing operational efficiencies of teaching hospitals. Another incidental finding is that teaching hospitals are not performing as well as their non-teaching counterparts in terms of scale efficiency. However teaching hospitals operate at more optimal scale than non-teaching hospitals in terms of MPSS ratios.

The possible reason behind this, teaching hospitals might be separated into high efficient to low efficient frontiers. Furthermore standard deviation of scale efficiencies for teaching hospitals is 0.17 while for non-teaching hospitals it is 0.09. This significant difference of standard deviations between teaching and non-teaching hospitals contributes to the existence of separation between high and low efficient frontiers. These findings show that, high efficient teaching hospitals increased the MPSS ratio while low efficient ones decreased the average scale efficiency.

The other significant finding is that technical efficiency, known as a managerial efficiency in DEA literature (Sinha, 1996; Charnes and Cooper, 1980; Caves and Barton, 1990), has rather contribution to the inefficiencies of teaching hospitals than pure technical efficiency. According to Karagoz and Balcı (2007), management has a critical role in solving health care problems in world health circle. Similarly, Zaim et al. (2008) stated, managers of health care organizations should determine objectives, and set specific measurable goals to satisfy customer expectations and improve their organizations' performance in Turkey.

Moreover, the patterns of efficiency changes of teaching and non-teaching hospitals are analyzed over the study years. This analysis provides the evidence that the efficiencies of both teaching and non-teaching hospitals have a statistically significant negative trend. Additionally MPI analysis results show that non-teaching hospitals can be separated into high efficient and low efficient frontiers. Thus, health care policy makers should inevitably take into account these differentiations with regard to define necessities of high and low efficient hospitals.

Besides, considering the MPI results, both teaching and non-teaching hospital efficiencies decline in 2004 when compared to prior year efficiency scores. As mentioned before Performance-based payment system (PBP) was implemented across Turkey in 2004. An underlying goal of the PBP system is to encourage hospitals to use their resources more productively.

However in many case performance gains from PBP system is not realized to the extent predicted for short-term expectations. Analysis showed that the efficiency trend of hospitals was generally reduced after the implementation of PBP system in Turkey. However it would be misleading, and to some extent unfair, to simply assume the above mentioned argument against the success of PBP system, without considering the long-term efficiency trends of hospitals.

As similar to the findings of this section, Aletras et al. (2007) examined the effect of health care reforms on hospital efficiency in Greece and noted that the expected benefits from the health care reform have not in general been materialized in the short-run. Also Aletras et al. (2007) argued that the improvement of the performance of comprehensive health care reforms should be assessed in the long-term. Therefore health care reforms that expected to improve performance should be inevitably implemented especially in developing countries with assessing the short-mid and long term effectiveness.

With the reference to the inefficiencies of capacities and the utilization of capacities and to the breadth of needs, teaching hospitals take more measures than the non-teaching hospitals. According to the results, medical labor capacity as input perspective and the utilization of the physical capacity and utilization of technological capacity as output perspective are the most important inefficiency causes for both teaching and non-teaching hospitals.

Thus, one of the most significant findings of the analysis is that significant potential improvement should be performed for average physical capacity and also the utilization of the physical capacity. Hospitals should reduce their physical capacity in order to become efficient. However reduction of the physical capacity is not a valid approach for hospitals.

This finding is in line with the research of Katharaki (2008) which analyzed the efficiencies of Greek O&G hospital units. Katharaki (2008) noted an alternative proposal to the limitation of the physical capacity which is the development of initiative and administrative measures which could contribute to the utilization of the production factors. In addition to the proposal of Katharaki (2008) the following proposal related to the investments is suggested in this section. Since a great deal of investment is prepared for teaching hospitals especially in developing countries such as Turkey, these investments should be well planned in order to eliminate idle physical capacity.

Although inefficiency of physical capacity is not a significant problem, shortages of the utilization of physical capacity are underemployed by more than 65% for hospitals (69.66% for teaching hospitals and 75.82% for non-teaching hospitals, see in Table 4). Thus, output capabilities associated with the high average inefficiencies for both teaching and non-teaching hospitals are related with the utilization of physical capacity.

Considering the inefficiencies of physical capacity for input and output perspective, two important policy relevant conclusions can be drawn. Firstly, to increase the economies-of-scale, inefficient hospitals might seek strategic alliances with other inefficient hospitals, via vertical and/or horizontal integration. When considering strategic alliances it is essential to evaluate the regional properties especially for patients, shared goals and objectives and also comparable institutional culture within two or more hospitals. Secondly, although downsizing is not a preferential alternative for hospitals, hospital administrators occasionally consider downsizing in order to become efficient.

From the perspective of existing capacity inefficiencies, medical labor capacity that excesses with regard to the non-specialist physicians has a vital role for the inefficiencies of teaching hospitals in Turkey. Since reducing labor may only support short-term improvements, for service organizations such as hospitals the reduction of physicians is not a realistic attitude. Therefore administrators of teaching hospitals should find valid solutions for the effective utilization of existing medical staff. They might perform the quantitative staffing models such as operational scheduling for physicians.

Also excesses of non-specialist physicians might be taken into service in the basic treatment units by using sophisticated mathematical techniques. The use of linear programming, simulation modeling and other mathematical tools will support a broad range of processes, including medical labor scheduling, patient routing, wait line and service delivery, and department or resource location analysis (Langabeer, 2008). As Lee et al. (2009) argued, it is also necessary to develop human resource management strategies concerning the effective utilization of medical labor capacity which will result in improved individual and organizational performance.

In spite of expected knowledge, interestingly, the shortage of the utilization of technological capacity in teaching hospitals is considerably much more than non-teaching counterparts. However, this is a significant opportunity for teaching hospitals in order to increase their operational efficiencies without any new investments. Accordingly investment plans and budgets should be laid out considering these shortages.

On the other hand Ouellette and Vierstraete (2004) briefly argued that hospitals are forced to hire new specialized staff and technological equipments to keep abreast of the rapidly changing and developing technological environment. Most of hospitals and health care organizations do not carefully plan their operations, therefore technological capacities of hospitals have unplanned increase without detailed requirement plans. In parallel, Koenig et al. (2003) conclude that teaching mission increased the actual costs almost 60 percent and the rest was explained by additional underutilized technological capacities.

Moreover results in improved patient outcomes according to the advanced technologies are still uncertain. Nevertheless reduction or limitation of technological capacities is not an option for hospitals, since medical technologies are rapidly developing in today's health care system. Thus, teaching hospitals have to develop a comprehensive planning system for effective usage of technological capacity. In line with this, Zuckerman (2005) noted that planning is one of the key management functions necessary for hospital growth and effective execution. Furthermore, alternative proposals should be developed for eliminating the ineffective utilization of technological capacities for teaching hospitals.

As noted above, teaching hospitals have an option to seek strategic alliances with other hospitals for effective usage of the idle technological capacities. This is a health care policy relevant decision for hospitals; therefore administrators should be careful in their decisions. A well developed operational planning could identify external opportunities, threats and internal strength, weakness to define strategic alternatives (Langabeer, 2008) such as seeking strategic alliances or deciding to perform new technological investment. Therefore we clearly noted that especially operational planning has a vital priority for effective utilization of hospital capacities.

Finally, our research suggests that both teaching and non-teaching hospitals should focus on increasing the utilization of institution capacities for patients. However there is a significant difference between teaching and non-teaching hospitals in this improvement area. As mentioned above, individual input and output slacks as well as capacity dimensions were used in order to identify inefficiency causes of hospitals.

According to the input and output slacks as shown in Table 7.17, it can be concluded that average augmentation of outpatients is 51.13%, while it is 11.72% for inpatients in teaching hospitals. Yet the average augmentation of inpatients is 34.33% and 10.54% for outpatients in non-teaching hospitals. Therefore, emphasis should also be placed on the outpatients for teaching hospitals and inpatients for their non-teaching counterparts. Nevertheless, it is plausible that the inefficiencies of the utilization of institution capacity should be improved by using appropriate strategies.

Two applicable alternatives can be suggested to hospital administrators in order to deliver better health care to their patients. Hospitals could care more patients or they could serve more quality health care services to their patients by using existing institution capacity. Since hospitals have more institution capacity than they currently utilize, these suggestions seems to be a feasible course of action.

7.3. Hospital Efficiency, Service Quality and Patient Satisfaction

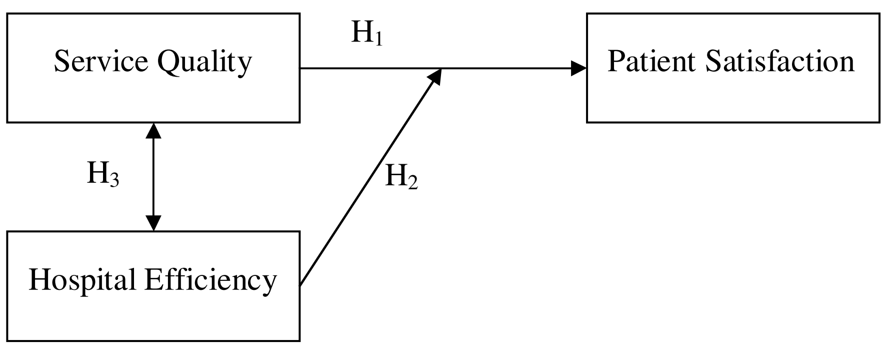
7.3.1. Introduction

This section focuses on a model that highlights the controversial relationships between hospital efficiency, service quality and patient satisfaction in a sample of Turkish hospitals. Data Envelopment Analysis (DEA) is used to analyze the technical efficiencies of hospitals and regression analysis is used to investigate the relationships between study variables. The findings of the study show that hospital efficiency has an indirect effect on patient satisfaction such that hospital efficiency changes the form of the relationship between service quality and patient satisfaction as a moderator variable. In addition, the trade-off between quality and efficiency has been discussed for different hospital size groups.

7.3.2. Research Model

The ambiguity concerning the impact of hospital efficiency and service quality on patient satisfaction arises in part, since these topics have previously been examined in isolation. However, these constructs are highly correlated. Therefore, they should be examined simultaneously. Yet, to the best of our knowledge, no study incorporating quality measures in the efficiency models while also analyzing their effects on patient satisfaction exists in the literature on health care sector. In light of the literature background, the proposed research model in this section is shown in Figure 7.1. In the current study, the relationships between hospital efficiency, service quality and patient satisfaction is aimed to examine by analyzing the following research model.

Figure 7.1. The proposed model of the study



In this model three different hypotheses are examined as follows;

Hypothesis 1: Service quality has a positive effect on patient satisfaction.

Hypothesis 2: Hospital efficiency changes the form of the relationship between service quality and patient satisfaction as a moderator variable.

Hypothesis 3: Hospital efficiency is correlated with service quality.

One of the major research questions in this section is that how hospital efficiency changes the form of the relationship between service quality and patient satisfaction, as depicted in hypothesis 2. Rather than having a direct effect on patient satisfaction, hospital efficiency will play a moderating role on the relationship between service quality and patient satisfaction. This is because the effects of efficiency measures, either negative or positive, show themselves in the form of patients' perceptions of service quality.

7.3.3. Operational Efficiencies of Hospitals

The aim of this section is to analyze the effects of hospital efficiency and service quality on patient satisfaction. In the first stage, technical efficiency DEA scores are analyzed as described by Fare et al. (1994). The constant return to scale (CRS) approach is applied in DEA calculations, as the mostly preferred method in similar contexts (e.g., Blank and Valdmanis, 2010). In Table 7.18, the descriptive statistics for the technical efficiencies along with the service quality and patient satisfaction indexes are presented.

From the hospital size perspective, small hospitals have on average overall efficiency of 0.80, however the total percentage of inefficient hospitals is particularly high (66%). Average efficiency of medium-size hospitals is 0.74 with a higher percentage of inefficient hospitals (84%). The large hospitals are the least efficient hospitals compared to other categories. Average efficiency of large hospitals is 0.73 which is quite similar with medium-size hospitals; however, percentage of inefficient hospitals is 86%. Additionally, there are 68 out of 348 hospitals in the sample that are assigned as %100 technically efficient in Table 7.18. These technically efficient hospitals comprise of 43 out of 182 hospitals for small-size hospitals, 13 out of 81 hospitals for medium size hospitals, and 12 out of 85 hospitals for large-size hospitals.

Table 7.18. Descriptive Statistics of Hospital Efficiency, Service Quality and Patient Satisfaction

	Technical Efficiency	Service Quality	Patient Satisfaction
All Hospitals (n=348)			
Mean	0.76	0.89	0.91
Std. Dev.	0.16	0.07	0.06
Min.	0.42	0.41	0.61
No. Full Score*	68	6	10
Small-size Hospitals (n=182)			
Mean	0.80	0.88	0.92
Std. Dev.	0.15	0.08	0.05
Min.	0.42	0.41	0.61
No. Full Score*	43	3	6
Medium-size Hospitals (n=81)			
Mean	0.74	0.90	0.90
Std. Dev.	0.16	0.06	0.07
Min.	0.46	0.67	0.61
No. Full Score*	13	1	4
Large-size Hospitals (n=85)			
Mean	0.73	0.91	0.88
Std. Dev.	0.15	0.05	0.07
Min.	0.42	0.74	0.74
No. Full Score*	12	2	0

* Number of hospitals for which technical efficiency = 1; service quality = 1; patient satisfaction = 1

7.3.4. Impact of Hospital Efficiency and Service Quality on Patient Satisfaction

To investigate the impacts of hospital efficiency and service quality on patient satisfaction regression analyses are used in the second stage. Model 1 in Table 7.19 presents the results of the first regression analysis. The model is significant at the $p<0.01$ level. Here, service quality significantly increases patient satisfaction providing support for Hypothesis 1. Besides, tolerance and VIF values provide the evidence that there is not any multicollinearity between these variables. The tolerance value is 1 minus the proportion of the variable's variance explained by the other variable. Therefore, high tolerance values indicate the little collinearity (Hair et al., 2010).

Although hospital efficiency has not any significant influence on patient satisfaction, there might be an indirect relationship between hospital efficiency and patient satisfaction. One of the major questions of this section was that "*how the hospital efficiency changes the form of the relationship between service quality and patient satisfaction*". Therefore, a second regression model was developed in order to examine this effect:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 X_2 + e \qquad (7.1)$$

In this model, interaction term ($\beta_3 X_1 X_2$) represent the moderator effect of hospital efficiency on the relationship between service quality and patient satisfaction. Here, service quality is represented by (X_1), hospital efficiency is shown by (X_2) and patient satisfaction is (Y). Model 2 in Table 7.19 demonstrates the regression analysis results.

Table 7.19. Regression Analysis Results

Model		Parameter Estimate	Standard Error	Significance	Collinearity Statistic	
					Tolerance	VIF
1	Service Quality	.167	.048	.002**	.992	1.008
	Hospital Efficiency	.009	.022	.868	.992	1.008
2	Service Quality	.202	.051	.000**	.862	1.160
	Hospital Efficiency	.022	.022	.688	.972	1.029
	Interaction Term	***-.095***	.294	.096*	.860	1.162

* Significant at $p < 0.10$

**Significant at $p < 0.01$

The second model is significant at $p<0.01$ level. Regression analysis results suggest that hospital efficiency can be considered ($p<0.1$) as a negative moderator (β= -0.095) on the relationship between service quality and patient satisfaction. Since the interaction term representing the moderating effect is merely significant at $p<0.1$ level, further analyses have been conducted to provide additional evidence for the moderating effect. For this purpose, data has been mean centered and, then, split into low and high efficient groups. Then, regression analyses have been repeated distinctly for the two groups of hospitals (Table 7.20).

Table 7.20. Regression Analysis Results of Low and High Efficient Hospitals

		Parameter Estimate	Standard Error	Significance
Low Efficient Hospitals				
	Service Quality	0.248	0.070	0.001**
	Hospital Efficiency	0.070	0.056	0.327
High Efficient Hospitals				
	Service Quality	0.099	0.067	0.214
	Hospital Efficiency	0.073	0.068	0.362

**Significant at $p < 0.01$

Results in Table 7.20 show that high levels of hospital efficiency lessen the positive effect of service quality on patient satisfaction. In other words, for high efficient hospitals, the relationship between service quality and patient satisfaction is weak and non-significant (β=0.099; p>0.1) while for low efficient hospitals, there is comparatively a stronger positive effect of service quality on patient satisfaction (β=0.248; p<0.01). Thus, hospital efficiency variable exerts a negative moderation between service quality and patient satisfaction, as we hypothesized.

As mentioned before, the relationship between efficiency and quality can be defined in two ways, namely as traditional approach or TQM approach. In order to compare these approaches the correlation between hospital efficiency, service quality and patient satisfaction was examined. Since hospitals might operate with different economies of scale, relationships are examined in terms of hospital-size. Correlation coefficients are presented in Table 7.21.

Table 7.21. Correlation between Hospital Efficiency, Service Quality and Patient Satisfaction

	Pearson Correlation	Significance
Small-Size Hospitals (n=182)		
Efficiency – Quality	-0.186	0.012**
Efficiency- Patient Satisfaction	-0.060	0.424
Quality- Patient Satisfaction	0.136	0.066*
Medium-Size Hospitals (n=81)		
Efficiency – Quality	0.069	0.541
Efficiency- Patient Satisfaction	-0.093	0.410
Quality- Patient Satisfaction	0.358	0.001**
Large-Size Hospitals (n=85)		
Efficiency – Quality	0.183	0.093*
Efficiency- Patient Satisfaction	-0.013	0.904
Quality- Patient Satisfaction	0.301	0.005**

* Significant at $p < 0.10$

** Significant at $p < 0.01$

The table above demonstrates that there is a significant negative correlation (-0.186) between efficiency and quality for small-size hospitals as expected due to traditional approach. No significant correlation was found for medium-size hospitals. On the other hand, there is a significant positive correlation between efficiency and quality for large-size hospitals. It is apparent that there are differences in correlation results between small-size and large-size hospitals. That is, traditional approach of efficiency and quality trade-off is supported for small-size hospitals while TQM approach becomes dominant for large-size hospitals. In general, the correlation results provide support for Hypothesis 3.

Furthermore, to evaluate whether the differences of efficiency, service quality and patient satisfaction are statistically significant among the hospital size, Kruskal-Wallis test is conducted. The null hypotheses being tested are that there are no differences in terms of efficiency, quality and patient satisfaction between the three groups of hospitals. The null hypotheses of equal means are rejected at 0.001 level of statistical significance. Therefore, we found that the differences in efficiency, quality and patient satisfaction of hospitals are statistically significant with respect to the hospital size.

7.3.5. Discussion

In this study, the effects of hospital efficiency and service quality on patient satisfaction as well as the controversial relationship between hospital efficiency and service quality is empirically evaluated. In particular, DEA was employed to analyze technical efficiencies of hospitals.

According to the results, small-size hospitals are relatively more efficient and have higher patient satisfaction compared to other types of hospitals. However, large-size hospitals provide comparatively higher quality of care than their small and medium size counterparts. It is not plausible that such differences between hospital types are simply the result of diseconomies of scale or dissimilar applications of hospital management.

Regarding the direct impacts of hospital efficiency and service quality on patient satisfaction, in parallel with the studies of Etgar and Fuchs (2009), we show that service quality has positive and significant influence on patient satisfaction for all size of hospitals. This means that hospital administrators need to focus on improving service quality in order to increase patient satisfaction. On the other hand, for the sample of Turkish hospitals, efficiency has no direct effect on patient satisfaction.

Considering the moderating effect of hospital efficiency, hospital efficiency negatively moderates the relationship between service quality and patient satisfaction. This means that expected changes in patient satisfaction as a result of improving service quality might be influenced by the level of hospital efficiency. Hospitals improving their service quality may also be working for improving their efficiencies such that they can eliminate waste and reduce their costs. If the hospital management gives more emphasis on the efficiency issues such that the patients think that efficiency comes first, this may impose a negative perception that could alleviate the strength of the relationship between service quality and satisfaction. This possibility is partially demonstrated in this section by regression results of the moderating variable.

Results also show that technical efficiency is associated with poor service quality for small-size hospitals. However, large-size hospitals could improve both their technical efficiency and service quality levels. Thus, contrary to the frequent assumptions of traditional approach of efficiency-quality trade-off, findings indicate that efficiency and quality improve together for large-size hospitals, as indicated by TQM approach.

Nonetheless, empirical evidence is found about the negative correlation between quality and efficiency for small-size hospitals. These results are particularly interesting because the main assumptions of two different theories are confirmed, but for different hospital size groups. That is, efficiency and quality relationship can be differently assessed for varying hospital sizes.

7.4. Hospital Efficiency and Health care Expenditures

7.4.1. Introduction

This section examines the relationship between hospital efficiency and health expenditures in Turkey, and addresses the impact of Performance-Based Payment

(PBP) system on the efficiencies of public and private hospitals. In an effort to comparatively analyze the efficiencies of public and private hospitals, this section uses data envelopment analysis (DEA). Malmquist Productivity Index (MPI) is also used to analyze the patterns of efficiency change for the study years. This study shows that health expenditures and hospital efficiency are negatively correlated for private hospitals, while they are positively correlated for public hospitals. Findings also indicate that average efficiencies of public hospitals tend to increase particularly in the implementation period of PBP system. The efficiency trend of private hospitals, conversely, decreased in the latter periods of PBP system. Suggestions for improvement are provided to the health care policy makers regarding the impact of health care reforms on public and private hospitals.

7.4.2. Operational Efficiencies of Public and Private Hospitals

The multistage analysis process was conducted. In the first stage, Data Envelopment Analysis is applied to analyze the relative efficiencies of public and private hospitals. Then, Malmquist Productivity Index is calculated to examine the productivity trends of hospitals. Inefficiency causes of hospitals are investigated by slack analysis. In the last stage, Spearman Correlation is used to assess the relationship between health expenditures and hospital efficiency.

In this research, public and private hospitals are evaluated separately in order to examine efficiencies of hospitals in the period of 2001 to 2008. As Chang et al. (2011) argued to ensure greater homogeneity in efficiency analysis across comparable units, and taking sample size variations into account, we focus on separately evaluating the efficiencies of public and private hospitals. Thereby, hospitals are benchmarked in their peer groups.

Input oriented model and constant return to scale (CRS) approach of DEA is used to analyze technical efficiencies of hospitals. Since CRS score captures global (technical) efficiency, technical efficiency scores is preferred to compare the public and private hospitals as suggested by Lee et al. (2009). Average efficiency statistics of hospitals to the years of 2001 to 2008 are presented in Table 7.22.

Table 7.22. Technical Efficiency Scores of Hospitals

	Public Hospitals		Private Hospitals	
2001	n=409	0.69 (0.20)	n=68	0.77 (0.21)
2002	n=420	0.70 (0.20)	n=84	0.73 (0.22)
2003	n=424	0.69 (0.20)	n=102	0.78 (0.20)
2004	n=448	0.70 (0.19)	n=118	0.71 (0.22)
2005	n=417	0.68 (0.20)	n=152	0.75 (0.20)
2006	n=425	0.73 (0.19)	n=183	0.66 (0.25)
2007	n=419	0.71 (0.19)	n=307	0.62 (0.24)
2008	n=423	0.73 (0.18)	n=318	0.61 (0.24)

Standard deviations of efficiency scores were given in the parenthesis

The efficiency analysis reveals, on average, a better technical efficiency in private hospitals than public hospitals for the period of 2001 to 2005. In contrary to this, average efficiencies of public hospitals slightly increased from 0.68 in 2005 to 0.73 in 2008 immediately after the quality-adjusted PBP system was started to implement across Turkey.

Meanwhile, average efficiencies of private hospitals decreased from 0.75 in 2005 to 0.61 in 2008. The efficiency scores are 0.73 (average efficiency of public hospitals in 2008) and 0.61 (average efficiency of private hospitals in 2008) implying that hospitals use on average approximately 23% and 39% more inputs per unit of outputs than if they were all efficient, respectively.

Then, *t*-test is conducted to determine if there is a significant difference among technical efficiencies of public and private hospitals. Statistically significant differences are noted in the inputs used (i.e., number of specialized physicians, number of non-specialized physicians and total number of hospital beds) and the outputs produced (i.e., bed utilization rate, bed turnover rate, total surgical operations, number of births, total outpatient visits, average facility inpatient days, number of discharge) between public and private hospitals.

Statistical difference observed between public and private hospitals can also be attributable to the size of the hospitals. Thus, *t*-test is employed again by dividing the hospitals into three categories, based on the number of beds; as small (less than 100 beds), medium (100-199 beds), and large (200 or more beds) to compare the mean differences in technical efficiency between public and private hospitals (Lee et al., 2009). Similar significant differences are found between public and private hospitals in terms of number of beds.

7.4.3. Patterns of Efficiency Changes

Patterns of efficiency changes of public and private hospitals are analyzed for the former periods and the implementation period of PBP system by using Malmquist Productivity Index (MPI). Table 7.23 summarized the productivity change index and its components. The MPI and its corresponding components are all calculated as an index form (Lyroidi et al., 2006). The values of the efficiency change, technology change and malmquist index are higher, equal or lower than 1 with respect to whether the efficiency of hospital improves, remains stable or declines between the periods.

Table 7.23. Productivity Trends of Hospitals

	Public Hospitals			Private Hospitals		
	EC	TC	MPI	EC	TC	MPI
Pre-PBP (2002-2004)	0.990	0.982	0.981	1.024	1.002	1.016
PBP Implementation (2005-2008)	1.017	1.005	1.018	0.974	0.977	0.967

EC: Efficiency Change; TC: Technology Change; MPI: Malmquist Productivity Change

Following the suggestions of Yu and Ramanathan (2008), geometric means of MPI scores (decomposed to the efficiency change and technology change) are calculated to analyze the trends of changes in efficiency, technology and malmquist index. The geometric means of Malmquist Productivity Index (MPI) of public hospitals is found to be 1.018 in the implementation PBP period while it was 0.981 in the pre-PBP period.

It is evident that the efficiencies of public hospitals have a negative trend in pre-PBP period while have a positive trend in the PBP implementation period. Thus, it is found that the efficiency trend of public hospitals slightly increased after the implementation of PBP system. With respect to private hospitals, efficiencies have positive trend in the pre-PBP period (1.016) while, have a negative trend in the implementation PBP period (0.967). The *t*-test is also applied in order to determine statistical differences of MPI scores between the periods. The productivity trends of public and private hospitals presented in Table 7.23 are deemed as statistically significant.

7.4.4. Inefficiency Analysis of Public and Private Hospitals

As noted by Harrison and Kirkpatrick (2009), an imperative characteristic of DEA is the ability to determine slacks within individual hospitals. These slacks reflect either surplus for inputs and/or shortages for outputs. Thereby, inefficiently used inputs and not sufficiently produced outputs can be determined by health care administrators. Table 7.24 shows the average amount of slack among inefficient hospitals compared to the efficiency frontier. These results represent the combined scores of slack for all inefficient public and private hospitals. Percentage change of inputs and outputs are also shown in the table.

From an input perspective, the results show that the excess of the number of physicians is the main inefficiency causes of public hospitals while this ratio is quite fewer for the private hospitals. Possible reduction of the number of non-specialist physicians that might be achieved is, on average, 21.89% for public hospitals while the average reduction in the number of specialist physicians is 15.75%. Even though, there is an excess in the number of specialized physicians (4.49%), excesses of non-specialized physicians (14.69%) is the prior cause of the high average inefficiencies for private hospitals in the perspective of input factors. Besides, there is a considerable difference about the excesses of hospital beds between public and private hospitals. Particularly, the reduction in hospital beds that might be achieved is, on an average, 4.36% for private hospitals and 0.26% for public hospitals.

Table 7.24. Inefficiency Evaluation of Hospitals

	Public Hospitals		Private Hospitals	
	Mean	Percentage of Change	Mean	Percentage of Change
Input Slacks				
Specialized Physicians	1.01 (0.57)	15.75	0.96 (0.40)	4.49
Non-specialized Physicians	9.48 (2.06)	21.89	0.45 (0.18)	14.69
Hospital Beds	0.53 (0.37)	0.26	2.28 (1.61)	4.36
Output Slacks				
Bed Utilization Rate	88.40 (43.30)	160.58	21.69 (8.54)	55.79
Bed Turnover Rate	114.10 (44.01)	261.53	62.62 (43.37)	82.03
Surgical Operations	221.24 (141.24)	14.88	182.82 (43.37)	28.54
Number of Births	916.08 (217.92)	86.33	399.62 (203.87)	86.87
Outpatient Visits	89957.05 (39048.46)	34.73	5812.88 (3121.58)	13.48
Facility Inpatient Days	2.64 (1.74)	57.07	0.11 (0.09)	5.68
Number of Discharge	556.41 (382.34)	6.50	389.95 (190.79)	10.82

Standard deviations were given in the parenthesis

An analysis of the inefficiency of the output variables shows significant potential savings are possible for public and private hospitals. In order to become efficient, bed utilization rate and bed turnover rate should be increased, on average 160.58% and 261.53% for public hospitals, while 55.79% and 82.03% for private hospitals, respectively. Although an excess of the beds is an inferior factor, utilization rate of the existing beds should be improved especially for public hospitals. Considerable difference between public and private hospitals is also found about the promotion of the number of patients. The average number of outpatients and inpatient facility days could be increased by 34.73% (13.48% for private hospitals) and 57.07% (5.68% for private hospitals) for public hospitals, respectively. Thus, public hospitals should consider the need to deliver health care to more patients through effective usage of their existing resources.

7.4.5. Relationship between Hospital Efficiency and Health care Expenditures

In this section, the association between hospital efficiency and health expenditure is also aimed to assess in a comparison between public and private hospitals. Non-parametric Spearman correlation is used to analyze these relationships. Table 7.25 represents the correlation analysis results.

Table 7.25. Correlation between Efficiency and Expenditure

		Technical Efficiency	
		Public Hospitals	Private Hospitals
Health Expenditure	Correlation Coefficient	0.675	-0.762
	Significance	0.066*	0.028**

* Significance at p<0.10

** Significance at p<0.05

Using bivariate correlation analysis, a significant variation in hospital efficiency and health expenditure relationship is found between public and private hospitals. The results of the correlation analysis show that health expenditure is negatively related to private hospital efficiency. This suggests that increased health expenditures of private hospitals may reduce efficiency, as expected. Interestingly, a positive correlation between health expenditure and hospital efficiency is found for public hospitals. There is also considerable difference between correlation coefficients of public (β = 0.675) and private hospitals (β = -0.762). These results show that the relationship between efficiency and health expenditures is more sensitive for private hospitals as compared to public hospitals.

7.4.6. Discussion

This section examines the effects of the PBP system on the efficiencies of public and private hospitals in Turkey. Health care reforms such as PBP system focus on to improve the performance of health care systems by promoting competition between hospitals (Garcia-Lacalle and Martin, 2010). These reforms also force hospitals to be more efficient while providing high quality of care in pursuit of decreasing hospital expenditures (Sezen and Gok, 2009c).

This section has also analyzed the efficiencies of public and private hospitals for the periods of pre-application and after the PBP system to evaluate whether ownership-based hospital efficiency is related with health care expenditures.

Although PBP system has been implemented in all hospitals since the beginning of 2004, an extended system that integrated hospital performance and quality of care was implemented since 2005. Turkish Ministry of Health also established imperative targets that hospitals have to meet to ensure high service quality for patients in 2005. Therefore, hospitals are forced to increase service quality and efficiency in pursuit of patient satisfaction by using their existing budget and additional income provided by the PBP system. Hospital efficiencies are examined in the former (2001-2004) and the implementation (2005-2008) periods of PBP systems.

Efficiency analyses indicate that the average efficiencies of public hospitals tend to increase particularly in the implementation period of PBP system. While, the average efficiencies of private hospitals tend to decrease in the implementation period of PBP system.

Moreover, patterns of efficiency changes of public and private hospitals are analyzed by using Malmquist Productivity Index. The MPI results indicate that there was a negative shift in efficiency in the former period of PBP system for public hospitals. However, public hospitals have an increasing trend of efficiency in the implementation period of PBP system. Conversely, the efficiency trend of private hospitals decreased in the implementation period.

The findings provide the evidence that the efficiency trend of public hospitals were decreased in the former period of PBP system. However, this trend returns to increase in the implementation period. Consequently, findings indicate that PBP system has a positive impact on the efficiencies of public hospitals in contrary to private hospitals. As Lee et al. (2009) stated, the principal reason for the difference between public and private hospitals is the fact that although public hospitals utilized more inputs, they generated more outputs, especially in the successful management environment. This environment provided by the PBP system provides standardized work processes that facilitate the management activities such as organizing, directing, planning and controlling (Munson and Zuckerman, 1983).

Although private hospitals are benefited from the PBP system according to the management perspective, the main priority of the private hospitals is to maximize their profits. Since public hospitals do not receive priority consideration to profit maximization, they also increase the investments on the training and re-education of their medical staff (Lee et al., 2009). Furthermore, as public hospitals have more beds, they can provide a greater number of services. Therefore, public hospitals enhance their benefits from PBP system by holding qualified medical personnel.

Slack analysis is essential to find excesses in inputs used and shortages in outputs produced. As Chen et al. (2005) state, without the comprehensive knowledge about the inefficiency causes of the individual inputs and outputs, health care policy makers may set uniform performance standards based solely on the anticipated overall efficiency improvement.

According to the slack analysis for all hospitals included in this section, the most striking inefficiency cause is the number of non-specialized physicians from the input perspective. The average excess of non-specialized physicians is 21.89% for public hospitals while it is 14.69% for private hospitals. Since reducing the number of physicians is not a favorable situation, public and private hospitals should consider the effective utilization of their medical labor capacity.

Specifically, hospitals could develop specialized services by using excess of their physicians to meet the patients demand. In addition, this might have a positive monetary impact on the hospitals. Alternatively, health care policy makers may need to consider mobilizing their physicians from the existing hospitals to the newly established ones. The health care administrators should assess the legal conditions and regulations to effective utilization of medical capacity by using findings based on a slack analysis.

On the other hand, public hospitals should effectively utilize their existing beds in order to increase efficiency. Number of beds is an indicator of the physical capacity of the hospitals. Thereby, public hospitals have an opportunity to deliver health care by using their existing physical capacity without any new investments. Findings suggest that public hospitals could serve more quality health care to their patients by using existing physical capacity and medical personnel.

Since public hospitals evidence an increasing trend of efficiency in the implementation period of PBP system, effective utilization of their resources has been improved since 2005. Thus, the guidance of the PBP system is a feasible course of action to eliminate the inefficiencies of public hospitals. However, as slack analyses indicate, public hospitals should increase this improvement trend in order to enhance the benefits of health care reforms.

The PBP system force to improve economic performance of hospitals as well as ensuring their funding. Hospitals are encouraged not to spend more than the initial budget assigned while improving efficiency. The capitation payment model ensures additional funding for public hospitals as long as the quality of the service is at least similar to private hospitals. Furthermore, payments are adjusted to the complexity of the cases treated by PBP system. Since public hospitals have usually more capacity in terms of medical and physical than private hospitals, complex cases tend to be treated in the public hospitals. Therefore, additional income provided by PBP system is increased for public hospitals.

These additional incomes encourage public hospital to be more efficient in their processes in order to increase their funding. Public hospitals also intend to use their economic, physical and medical resources to improve the performance level. Therefore effective utilization of increased income without compromising efficiency improvement is one of the main targets of hospital administrators. This effort might be the cause of the positive correlation between health expenditures and efficiency for public hospitals.

On the other hand, private hospitals mainly aimed to increase profits and attempt to maximize stockholder wealth. As hospital competition has become more intense in the private health care sector, for-profit hospitals should become more economically efficient. To achieve this, it is imperative to reduce the health care costs by effective usage of resources. Therefore, private hospitals may increase efficiency by decreasing health expenditures as expected.

Private hospitals may have some difficulties about the PBP system in terms of efficiency. They compete with public hospitals to attract patients from the available market. However, private hospitals aimed to increase their profits in contrary to public hospitals. With increasing competition and health care reforms, hospitals have to be more competitive and efficient in their environment. Public and private hospitals should also effectively use their budgets in order to enhance the benefits of health care reforms by using their own strategies.

8. CONCLUSIONS AND RECOMMENDATIONS

This study has significant implications for health care policies since the findings indicate a need for managerial focus on the hospital efficiencies. The findings of this study are especially important for health care administrators such that the inefficiency causes may be eliminated by considering the following suggestions:

- Health care policy makers should take into account the ownership properties in order to identify the unique necessities in the improvement process and reforms.

- Investments should be well planned in order to eliminate idle physical capacity.

- Inefficient hospitals might seek strategic alliances with other inefficient and/or efficient hospitals.

- Hospitals should create integrated delivery networks in order to attempt to use their current capacities to manage similar operations in other geographic area for vertical or horizontal integrations.

- Downsizing might be an alternative for eliminating the inefficiencies.

- Hospital administrators should benefit from improved management and business education in order to provide effective utilization of resources and also effectively manage the new health care reforms such as Performance-Based Payment Systems.

- Sophisticated mathematical techniques might be used to identify physician requirements and to turn them into operation schedules.

- Non-specialist physicians might be taken into service in the basic treatment units.

- Quantitative staffing model should be performed to optimize the mix of employees.

- Human resource management strategies should be developed for an effective utilization of medical labor capacity.

- Administrators of hospitals should develop comprehensive operational planning systems.

- Budgeting and the decisions of new investments processes should be well planned with regarding to consider inefficient utilization of technological capacity.

- For an effective utilization of existing capacity, hospitals can either deliver health care to more patients or deliver more quality health care services to the patients.

- Emphasis need to be placed on outpatients for teaching hospitals and on inpatients for non-teaching hospitals in order to achieve better efficiencies.

- Administrators of teaching hospitals take more measures than non-teaching counterparts in terms of the improvements of capacity inefficiencies.

These policy suggestions may have serious effects on the health care business (and may result in some resistance), but they can force hospitals to operate in a more efficient manner. The latter indicates that existing hospital capacities provide a considerable room for improvement. Nevertheless, increasing capital inputs may not be beneficial strategy. Although technological improvements as well as capital expansions have been keys in increased efficiency, it may caused higher cost if implemented without careful planning (Ozcan, 2009).

As mentioned above, integration either vertical or horizontal may be one of the key solutions for eliminating inefficiencies and effective usage of current capacities for hospitals. Horizontal integration refers to consolidation, mergers, acquisitions or alliances between hospitals. Several multihospital systems may be resulted by implementing horizontal integration. Multihospital systems mean an organized system of hospitals that share central services, common ownership assets and/or centralized management. Vertical integration refers to the acquisition or alliances of other parties involved in other segments of the health care such as pharmacist, stakeholders, clinics or physicians (Langabeer, 2008).

The evidence-based health care policy makers should take into account these findings to discover potential opportunities in order to increase efficiency. Accordingly, enhancement of efficiency provides the contribution to the improvement of hospital performance.

On the other hand, hospitals may increase their level of efficiency, service quality and patient satisfaction if they examine their operations carefully and try to emulate their successful peers. Advancements in hospital efficiency are expected to lead to improvements in service quality and patient satisfaction in the long run. Therefore, hospitals should not ignore efficiency gains in order to increase quality and patient satisfaction. Considering the relationship between efficiency and patient satisfaction, hospitals should need to optimize patient and other process flows by using the following suggestions (Langabeer, 2008):

- Understand patient demand
- Align capacity and resources with demand
- Manage patient and asset flows through tracking systems

According to the study findings, hospital efficiency has been shown to have an indirect effect on patient satisfaction, and this effect might be improved for small and medium size hospitals by taking large hospitals as role models. For this reason, role models should be determined for small and medium size inefficient hospitals in order to benchmark successful large hospitals.

Turkish hospitals should take into account to improve their efficiency levels in order to eliminate the inefficiency causes. Therefore, operations management techniques can be guides for health care administrators. The use of analytical operations management techniques and tools may help hospitals achieve better results while improving efficiency levels. In case, following suggestions regarding to operations management applications for hospitals are drawn by Stevenson (2002):

- Develop efficiency measures for all operations in hospital
- Decide the operations or procedures which affect the efficiency improvements
- Develop methods for achieving efficiency improvements
- Reengineer care delivery and business processes
- Establish feasible standards and improvement goals

- Demonstrate management's support to the efficiency improvements

- Measure and publicize improvements

Besides, as Herzlinger (1999) stated, operations management techniques can be used to drive improvements and efficiencies into the health care systems. The aim of these techniques can be broadly defined as follows (Langabeer, 2008):

Reduce Costs: Operations management techniques are used to take costs out of the health care systems. Finding waste, effective utilization, stabilizing and reducing the overall cost of delivering services are important functions.

Reduce Variability and Improve Logistics Follows: Investigate the most efficient and optimal paths for movement of resources, whether those resources are physical or information follow.

Improve Quality of Patient Services: Improved quality provides reduced medical errors and improved patient safety, as well as improved patient satisfaction.

Continuously Improve Health Care Processes: Operations management tools is used to carry out health care processes while improving process efficiency and effectiveness.

The use of operations management techniques, such as wait time minimization models, forecasting algorithms and etc. provide the contribution on the improvement activities. Detailed information about the implementation of operations management techniques in health care sector can be found in the studies of Hill (2005), Jacops (2006), Langabeer (2008) and Ozcan (2009).

8.1. Future Suggestions

There is obviously room for further studies on the relationships between efficiency, service quality, patient satisfaction and expenditures in the health care sector. Further research can focus on technological, managerial, and structural factors that affect the inefficiencies of hospitals. In addition, further research may analyze the operations management techniques that provide the solutions to the inefficiencies of hospitals.

This study can be also seen as a first attempt towards examining the relationships between service quality, hospital efficiency and patient satisfaction. Here, hospital efficiency and service quality are considered as the predictor variables. However, the factors affecting quality and efficiency in hospital environments should also be investigated. Therefore, future research studies may be concentrated on the antecedents of service quality and hospital efficiency.

The need for measuring efficiency, quality and patient satisfaction has been largely driven by the new reform programs of Turkish Ministry of Health. The objective in such reform programs is not only to improve patient satisfaction, but also to provide better service quality and obtain higher efficiency. The relationships observed between efficiency, quality and satisfaction may change in time, and, therefore, another research avenue is to compare the efficiencies of hospitals before and after applying the reform programs.

As an example, the effect of technology could be analyzed by using Malmquist Productivity Index in the panel data. Secondly, economic approach and allocative efficiency was not examined in this study because of the missing data of cost and prices. Relationships between technical efficiency and economic efficiency can be assessed in the further studies.

Finally, this study also examines the relationship between hospital efficiency and health expenditures in Turkey, and addresses the impact of Performance-Based Payment System on public and private hospitals. Future research may analyze the long term effects of PBP system on the hospital efficiencies in order to examine the varying impacts.

8.2. Limitations of the Study

Some limitations of this study should be acknowledged. First of all, selecting a set of input and output variables for evaluating the efficiency and inefficiency causes of hospitals is always challenging. Furthermore some additional variables such as the number of laboratory properties, high-tech equipments such as MR, number of intensive care units, etc. might be used to define the utilization of technological capacity as well as teaching and research variables.

However these variables could destroy the homogeneity between hospitals by giving extra credit to either one, therefore, these variables are not added into the input or output sets. Consequently, depending on the size and availability of data, certain input and outputs are selected. Some additional refinement of the inputs and outputs that define the capacity variables of hospitals might be used for future studies.

Secondly, the measure of quality of care is not included in the panel data analyses (Sections 7.1., 7.2. and 7.4.). However we have to note that most of the similar studies in DEA literature exclude the quality dimension due to its conspicuous absence (Chang et al., 2004) and subjectivity. Thirdly, sensitiveness of DEA to the random noise has been reported as a problem (Nayar and Ozcan, 2008). However Jacops (2001) and Linna (1997) noted that both DEA and parametric methods provide empirical sufficiency for evaluating the efficiencies.

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