THE IMPACTS OF HEALTH SECTOR REFORM ON THE EFFICIENCY AND PRODUCTIVITY OF PUBLIC AND PRIVATE HOSPITALS IN TURKEY

A Master's Thesis

by

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To Mommy

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of
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ABSTRACT

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Hospitals consume the largest share of government health resources. Since they account for such a large share of health expenditure, improvements in their efficiency and productivity will yield tremendous benefits for the entire health sector. On this basis, in 2003, the government of Turkey declared a reform program called "*Transformation in Health*". This study by using a rich panel data of 440 hospitals operating in 81 province in Turkey (observed throughout 2001-2007 i.e. pre and post reform periods) addresses the impacts of health sector reform on the efficiency and productivity of the public and private hospitals by employing Data Envelopment Analysis (DEA), bootstrapping and Malmquist productivity index. The results of the analysis indicate that slightly reduced efficiency of previously SSK owned hospitals have been more than offset by increased efficiency in MoH hospitals as well as in private and university hospitals, leading to an accessible, standardized and higher quality health services covering almost the whole population and that in overall, the reform has improved the productivity of all hospitals implying that health sector reform has succeeded.

Keywords: data envelopment analysis, Malmquist productivity index, bootstrapping, health sector reform, hospital efficiency and productivity

ÖZET

SAĞLIK REFORMU'NUN TÜRKİYE'DEKİ DEVLET HASTANELERİNİN VE ÖZEL HASTANELERİN ETKİNLİĞİ VE VERİMLİLİĞİ ÜZERİNDEKİ ETKİLERİ

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Devletin sağlık sektörü için ayırdığı kaynakların en büyük kısmını hastaneler tüketir. Sağlık harcamalarının büyük kısmının hastaneler tarafından tüketmesinden dolayı, hastanelerin etkinlik ve verimliliklerindeki iyileşmeler, tüm sağlık sektörü için büyük fayda sağlayacaktır. Buna dayanarak Türkiye'de 2003 yılında, hükümet "*Sağlıkta Dönüşüm*" olarak adlandırılan reform programını ilan etti. Bu çalışma, Türkiye'nin 81 ilinde faaliyet gösteren 440 hastaneyi içeren zengin bir panel veri kullanarak Sağlık Reformu'nun devlet hastaneleri ve özel hastanelerin etkinliği ve verimliliği üzerindeki etkilerini 2001-2007 yılları boyunca (reform öncesi ve sonrası dönem) Veri Zarflama Teknikleri, Malmquist Verimlilik İndeksi ve Bootstrapping Tekniği'ni kullanarak araştırmaktadır. Analiz sonuçları, Sağlık Bakanlığı'na ait hastaneler, üniversite hastaneleri ve özel hastanelerin etkinlik ve verimliliklerindeki önemli artışların daha önce SSK'ya ait olan hastanelerin etkinlik ve verimliliklerindeki az miktar düşüşe baskın geldiğini ve bu durumun nüfusun neredeyse tamamını kapsayan, ulaşılabilir, standart ve daha kaliteli sağlık hizmetlerinin sağlanmasına öncülük ettiğine ve bununla birlikte tüm hastanelerde önemli verimlilik artışları gözlendiğine işaret etmektedir.

Anahtar Kelimeler: veri zarflama teknikleri, Malmquist verimlilik indeksi, bootstrapping, sağlık reformu, hastane etkinliği ve verimliliği

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CHAPTER 1

INTRODUCTION

The period of 1980s, can be characterized as a new era in the world economic and political system due to the strengthening of the neoliberal ideas which support liberalization, deregulation, privatization and outsourcing of the public services. Hence, most of the welfare states began to implement various reform policies that are in line with neoliberal ideas in order to restructure their public service sector. Starting with the 1990s, as a response to neoliberalism, Turkey began to experience a period of reform process in its public service sector. With the elections of November 2002, the newly elected government has designed series of reform packages. In December 2003, Turkish government declared a reform program called "Transformation in Health". The main objectives of reform could be summarized as follows: setting up a single retirement insurance regime that includes short and long term insurance branches other than health insurance; creation of a general health insurance towards financing the provision of a high quality health service for all population, which is fair, equal, protective and curative; gathering of social benefits and services that are currently being carried out in a scattered manner under one umbrella; establishment of a system based on objective benefit criteria and which is accessible by all groups who are in need and finally creation of a new institutional structure, which will ensure the provision of above mentioned services in a modern and efficient manner.

Despite its paramount problems, the Turkish health care system is now well on its way to structural change. The driving force behind the current momentum is Turkey's commitments to both IMF and the EU, coupled with having a majority government that is able to command the support of the legislature. Many critical steps have already been undertaken. In January 2005, all social security institutions in Turkey; namely, Social Security Association (hereafter "SSK"), Pension Fund for Civil Servants (hereafter "ES") and Social Insurance Agency of Merchants, Artisans and the Self-employed (hereafter "BK") are united under one roof under the supremacy of Ministry of Health (MoH) in order to terminate this four-partite structure of the social security system.

The social security reform which is currently being implemented includes restructuring of MoH to complete its institutional transformation from a mainly provider of services to a regulator of service provision with a view to developing policies, defining standards, controlling health care providers and monitoring the appropriate use of resources. To this end, the transfer of the management and control of the all public hospitals operated by the SSK, and merger of some these with those that were operated by the MoH have been expected not only to benefit from a better allocation of scarce health resources among hospitals, but also to utilize scale economies that are present to its fullest extent. Moreover, IMF-sought Social Security and Universal Health Insurance Law, increased the retirement age and unified all social security beneficiaries under one roof. This law, while broadening the coverage of the insured and hence increasing the demand for the public health service provision, had also repercussions on the demand for health service provision by private hospitals, since it allowed government employees, members of SSK and self-employed beneficiaries to benefit from the services offered by private hospitals.

Motivated by those developments in Turkish health sector, this study presents an empirical analysis of the relative efficiency and productivity of Turkish private and public hospitals before and after the reform by using a national data set obtained from the Republic of Turkey Ministry of Health. The methods used to assess relative efficiency and productivity are Data Envelopment Analysis (DEA) and Malmquist productivity index. The study improves upon the traditional DEA, efficiency and Malmquist productivity scores by employing a procedure called bootstrapping that permits to estimate bias corrected efficiency scores and productivity indices. Since bootstrap is seen as the only way of assessing statistical properties (i.e. bias, variance, confidence interval) of the efficiency estimators that comes from some data generating process, it allows to make statistical inferences based on those DEA-estimators, as opposed to the econometric approaches which argue that DEA techniques are non-statistical and that statistical noise caused by DEA-estimators may introduce bias. By using this method, the study investigates the impacts of health care reform on relative performances of public and private hospitals in Turkey over 2001-2007.

The organization of the thesis is as follows: The next chapter is reserved for a brief description of the Turkish health care delivery system and reform process. Chapter 3 is devoted to the survey of the DEA literature and Malmquist productivity index. Chapter 4 describes the methodology used in this study to measure hospital efficiency and productivity. Chapter 5 provides the information on the data used, discusses the main variables of the model and empirical results of the analysis and evaluates the impacts of the reform. Finally, Chapter 6 concludes.

CHAPTER 2

OVERVIEW OF THE TURKISH HEALTH CARE DELIVERY SYSTEM

2.1. Pre-Reform Period

Ministry of Health (MoH) was established in May 1920 to provide, control and coordinate the health care services throughout Turkey. Since those years correspond to the war years which would ultimately lead to the establishment of the Turkish Republic in 1923, with no established private health infrastructure, the MoH assumed the sole responsibility for the provision of health care services. Turkey’s health care structure relied on the Bismarckian tradition that based itself on the employment status which then led itself to a four-partite, non-universal social security and health service provision system.

The first attempt to constitute a social insurance fund came in 1946. With the establishment of SSK within the Ministry of Labor and Social Security, manual laborers working under a service contract (i.e. private sector and blue-collar public sector workers) were provided health insurance and several social protection insurances against industrial accidents, occupational diseases, sickness, maternity, invalidity, old-age pension and survivors insurance. The institution operated both as an insurer and a health care provider for its members and their dependents. SSK provided health care services through its own hospitals. The system was financed by premiums paid by its members and by transfers from state budget if a deficit occurs.

The social security and health insurance coverage had been broadened in 1950, with the establishment of ES. It was a pension fund for retired civil servants and it provided health insurance and health care services both for retired and actively working members along with their dependents. The members and their dependents were provided basic health care services at MoH (i.e. public) hospitals. In this insurance system, there was no specific health insurance premium collected from either active civil servants or pensioners. Instead, it was financed by state budget allocations. The disadvantage of the system was that since all the financing was done by state budget allocations, this caused a large deficit in MoH budget and so in general state budget. The system was operating in the following manner: The fund had financed all health care expenditures of retired government employees with only a 10 percent drug co-payment paid by users. Moreover, health care expenditures of active civil servants were met by their organizations via specific state budget allocations. After the completion of a specific period of state service, active ones became pensioners and began to benefit some privileges that were granted to pensioners only.

Finally, in 1971, BK was established. Hence, from 1971 onwards there were mainly three institutions that constitute Turkish Social Security System: SSK, ES, and BK. With the establishment of BK, the social security and health insurance coverage were extended towards the self employed. The scheme required *compulsory membership* and hence premium payments for the self-employed who were excluded from the Social Insurance Law. Those were crafts-people, artisans, and small business owners, technical and professional people registered through a professional chamber or association and shareholders of companies other than co-operatives. Nevertheless, the scope of coverage had increased by granting *voluntary membership* and premium payments to unemployed people, housewives, local community elders, people of Turkish origin (and carrying a foreign passport) who live in Turkey, and the unemployed wives of Turkish nationals working abroad. In 1983, voluntarily access to insurance through BK was extended to self employed agricultural workers (under Law 2926). In 1985-86, the scope of insurance was also extended to include health insurance. Since February 1999, health insurance had been extended to agricultural workers. Diverging from other social insurance systems, BK had no health facilities of its own but rather purchased the health services for its members by entering into contractual arrangements with other public health service providers, including the SSK hospitals. Thus, contributors of this system could only benefit from those hospitals that had contract with BK. Members of BK could choose the level at which they made their contributions that ranged from lowest premium payment level covering limited number of basic health care services to the highest. In this system, at first, the insured paid for the medical expenses and then got reimbursed by BK. Pensioners of the system had to pay 10%, whereas active members and their dependents pay 20% of drug costs.

In early 1990s, increased population and higher demand for health care services resulted in overcrowding and insufficiency of services provided in hospitals, unequal access to health care, unequal dispersion of health personnel and facilities among different geographic regions of Turkey and loss of confidence in public health services. As a response to those problems, during this period, Turkish health system experienced some unsuccessful reform attempts that aimed to increase the rate of population covered by social insurance programs, to set up universal health insurance to remove the inequalities within the system, to encourage private investment in health sector and to improve managerial efficiency of hospitals by giving them more independence and so promoting competition among public hospitals. Although the targets of reform were well-defined, the means of its implementation were not. However, it can be said that attracting private investment into the health sector which resulted in increased number of private hospitals was the only achievement of the reform in this period.

In addition to social security systems discussed so far, in 1992, *The Green Card* system was introduced in Turkey. In this system which is directly funded by government, with special authorization given to the MoH to issue Green Card, poor people earning less than a subsistence level of income which is defined by the law, are endowed with a special card giving free access to outpatient and inpatient care at the state and some university hospitals. With this card patients are able to meet all of their inpatient medical drug expenses, but not the expenses on outpatient drugs. The percentage of population covered by the Green Card system was 0.6 in 1992 but increased to 16.4 in 2001. This system continues to perform today but the expenditures for the almost 11 million Green Card holders have exceeded government allocations, and increased the budget deficit.

In early 2000s, although several attempts were made to establish financially sustainable, general health insurance system covering the whole population, they could not be implemented successfully. Thus, problems of the existing system had grown gradually. In this period, as shown in table 2.1.1., three major organizations ES, SSK, and BK covered 14.75%, 57.71% and 26.96% of population, respectively. Besides those listed; YOK (university hospitals), state economic enterprises, municipalities, other public institutions, special funds, foundations, Green Card system and private health insurance companies also played a role in the provision of health care services in Turkey. In 2000, %82.2 of the population were insured, and 80.9% of those were covered by a health insurance.

Table 2.1.1. The Population Covered by Social Insurance Programs

INSTITUTIONS	**2000**	**% in 2000**	**2003**	**2005**	**% in 2005**
I. THE PENSION FUND OF CIVIL SERVANTS IN TOTAL (ES)	8,230,201	14.75	9,238,101	9,270,512	13.89
1. Active Insured	2,156,176		2,408,148	2,402,409	
2. Pensioners (retired, invalid, widow, widower, orphan)	1,296,935		1,466,679	1,595,973	
3. Dependants	4,777,090		5,363,274	5,272,130	
II. THE SOCIAL SECURITY ASSOCIATION IN TOTAL (SSK)	32,192,374	57.71	35,064,765	41,166,730	61.69
1. Active Insured	5,283,234		5,655,647	6,965,937	
2. Voluntary Active Insured	843,957		697,630	266,558	
3. Active Insured in Agriculture	184,675		165,268	178,178	
4.Pensioners (retired, invalid, widow, widower, orphan)	3,339,327		3,935,523	4,308,186	
5. Dependants	22,541,181		24,610,697	29,447,871	
III. SOCIAL INSURANCE AGENCY OF MERCHANTS,ARTISANS AND SELF-EMPLOYED IN TOTAL (BK)	15,036,318	26.96	15,881,624	15,990,253	23.96
1. Active Insured	2,181,586		2,224,247	2,103,651	
2. Voluntary Active Insured	254,960		236,398	239,388	
3. Active Insured in Agriculture	876,148		923,204	1,011,333	
4.Pensioners (retired, invalid, widow, widower, orphan)	1,277,444		1,445,820	1,600,294	
5. Dependants	10,446,180		11,051,955	11,035,587	
IV.THE PRIVATE FUNDS IN TOTAL	323,569	0.58	295,653	306,169	0.46
1. Active Insured	78,495		70,925	75,552	
2. Pensioners (retired, invalid, widow, widower, orphan)	71,266		71,715	76,027	
3. Dependants	173,808		153,013	154,590	
VI. GENERAL TOTAL	55,782,462	100	60,480,143	66,733,664	100
1. Active Insured	9,699,491		10,358,967	11,547,549	
2. Voluntary Active Insured	1,098,917		934,028	505,946	
3. Active Insured in Agriculture	1,060,823		1,088,472	1,189,511	
4. Total Active Insured	11,859,231		12,381,467	13,243,006	
5. Pensioners (retired, invalid, widow, widower, orphan)	5,984,972		6,919,737	7,580,480	
6. Dependants	37,938,259		41,178,939	45,910,178	
SOCIAL INSURANCE COVERAGE WITH RESPECT TO HEALTH SERVICES	54,938,505		59,782,513	66,467,106	
RATIO OF INSURED POPULATION (Percent)	82.2		85.6	**92.0**	
RATIO OF INSURED POP. COVERED BY HEALTH SERVICES (Percent)	80.9		84.6	**91.7**	
IX. TOTAL POPULATION	67,893,000		70,692,000	72,520,000	

As table suggests, before the reform took place, private hospitals served for just %0.58 of the population whereas SSK was responsible for the health care delivery of %57.71 of the population which eventually led to overcrowding in SSK hospitals and unequal health service delivery among different institutions. Per constituency rates in table 2.1.2., clearly shows the extent of this inequality.

Table 2.1.2. Distribution, Endowments and Per Constituency Rates of Institutions

Institution	Number of Hospitals	Number of Beds	Beds Per Constituency	Number of Specialists	Specialists Per Constituency	Number of Practitioners	Practioners Per Constituency
MoH	751	87709	76	13837	367	28983	218
SSK	118	28517	536	4801	6705	3311	9723
University*	43	24754	-	8586	-	8760	-
Private	239	11922	27	8665	37	2870	113

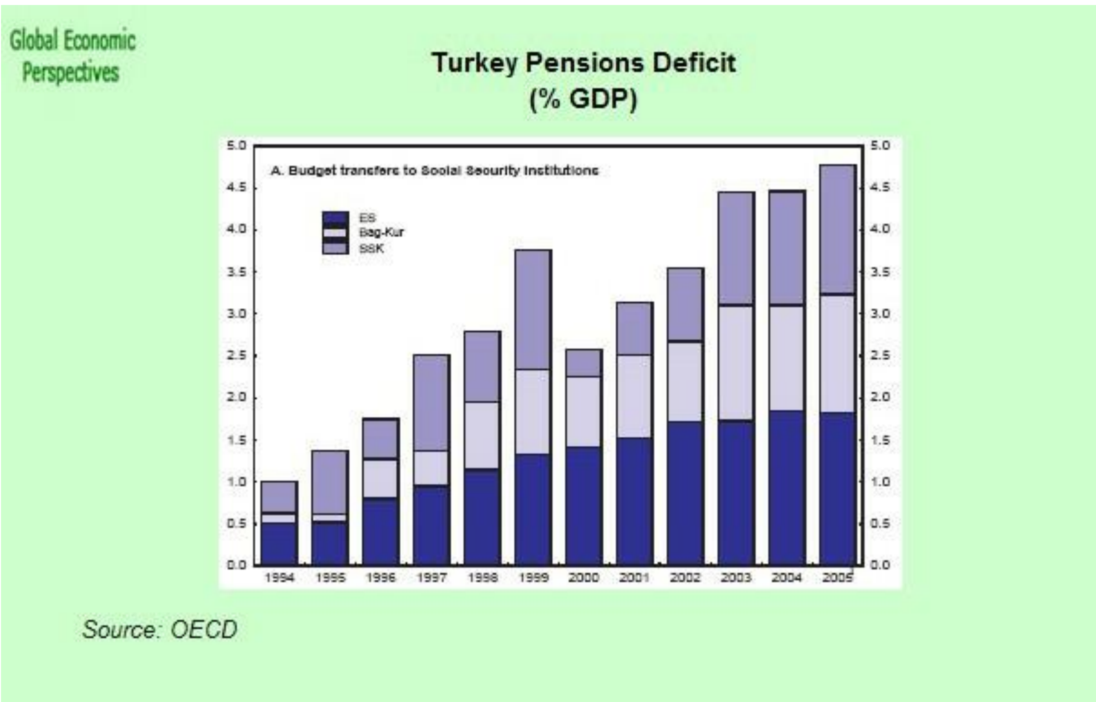
When compared to the rest of the institutions, SSK hospitals served for the maximum number of patients with minimum level of endowments before the reform. Obviously, in SSK hospitals, this would decrease the quality of health care and hence increase the inequality among patients treated. Thus, a successful reform attempt should be the one that could shift excess demand on SSK hospitals towards MoH and private hospitals in order to create more egalitarian health care delivery system.

According to table 2.1.1., over the period of five years however, with a rather increased burden on SSK, coverage have expanded by about %10 both with respect to ratio of insured population and with respect to ratio of insured population covered by health services. However, the broadened coverage of the social security system

*Note that since university hospitals operate under the rule of MoH, to obtain per constituency rates for MoH hospitals, the number of beds, specialists and practitioners in university hospitals are added to those of MoH. So, there is no need to calculate per constituency rates for university hospitals, separately.

has been achieved at the expense of ever growing deficits of all social security institutions even since the early 1990s. These deficits have required increasingly large transfers from the general government budget, prompting several reform attempts. The cumulative value of these deficits between 1994 and 2004, plus their debt servicing cost (based on the Treasury bill rate), was 475 billion YTL (about €200 billion) in 2004 prices, or approximately 110% of the 2004 GDP and 1.5 times the total consolidated debt stock as at the end of 2004. Indeed, the unsustainable social security system deserved a large part of the blame for Turkey's fiscal imbalances over the past decade.

Figure 2.1.1. Budget Transfers to Social Security Institutions (1994-2005)



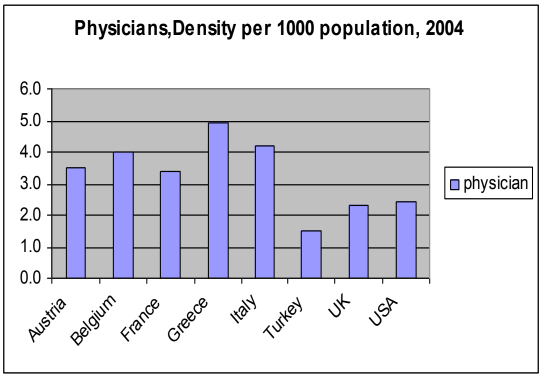
2.2. Transition Period

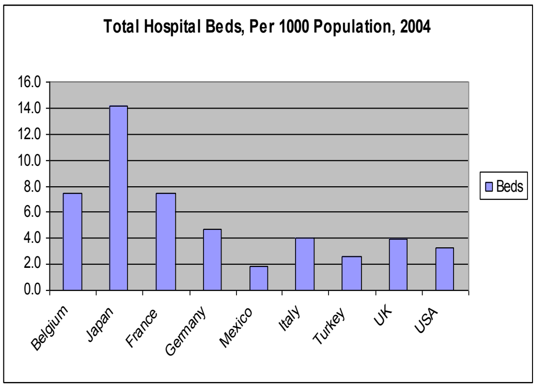
At the beginning of the year 2003, the government of Turkey has been in the process of designing a comprehensive reform of its social security system. The proposed reform has four basic components: (i) a pension reform aimed at unifying the currently disperse system and to increase the pension age to reduce the deficit of pension payments to revenues; (ii) introduction of Universal Health Insurance complemented with health sector reform; (iii) establishment of high quality, fair, protective, egalitarian and curative health care service for the whole population; and (iv) an institutional reform with the establishment of a unified social security institution.

Health sector reform has been an important and integral part of the social security reform since the rather dispersed and fragmented nature of the social security system also resulted in provision of health services in a rather dispersed manner such that each social security organization operating its own hospitals. Although the majority of the population was covered by the existing system, this partitioned structure of Turkish health system led to ineffective hospitals, low quality treatment and unequal access to health care services.

The weaknesses of the existing system could be better understood when basic health indicators of Turkey are compared to those of OECD countries. For instance, although the health expenditure has a large share in government's general budget (%4.3), total expenditure on health as a percentage of GDP is just 6 percent in Turkey, in 2003 whereas 15.1 in USA and 10.9 in France. Moreover, figure 2.2.1. shows that, in 2004, number of total hospital beds per 1000 population in Turkey is 2.6 whereas 14.2 in Japan and 7.5 in France and Belgium and physician density per 1000 population is 1.5 in 2004, in Turkey but 4.9 in Greece.

Figure 2.2.1. Hospital Beds and Physician Density per 1000 Population in Selected OECD Countries





Hence, in the light of those problems, in December 2003, with the support of IMF and EU, the government of Turkey declared a reform program called "Transformation in Health". The motto of the reform was "Health for everyone" and the aim was to restructure, both functionally and administratively, MoH, cover all citizens by general health insurance, give autonomy to hospitals; attract the private investment into the health sector; distribute health personnel and facilities equally among regions and provide effective, accessible, egalitarian and high quality health care system that unifies all social insurance organizations under one roof. The main principles of the reform that were in line with both 'Health for All in 21 st Century' Policy of the WHO and 'Accession Partnership' document prepared by the EU, were stated as human centrism, sustainability, continuous quality improvement, participation, division of power, decentralization and competition in service. (MoH, 2004: 70).

The reform process has been implemented gradually. First of all, as a result of the protocol signed between MoH and the Ministry of Finance in April 2003, civil servants are allowed to benefit from private health institutions. This reduced the excess burden on public hospitals without incurring any cost and enabled patients to save waiting time. This attempt could be considered as a first step towards unification of all social security institutions under a single umbrella.

As a second step, in July 2003, MoH, Ministry of Labor and Social Security and the Ministry of Finance signed a collective utilization protocol that enabled the members of BK, ES, active public employees and green card holders to benefit from SSK hospitals, and that enabled members of SSK to benefit from MoH (public) hospitals. The execution date of the protocol throughout Turkey was January 2004. With this attempt, the objective was to establish a common delivery and convergence in services of BK, ES and SSK which would enable equal access to health services, providing high quality treatment to patients and preventing patients to suffer from overcrowded hospitals.

As a third and final step, in Feb 2005, with law no 5502, ownership of all SSK hospitals are transferred to the MoH. Hence, with this final step unification process of the reform has been completed. Thus, all security institutions are united under the name of SGK (Sosyal Güvenlik Kurumu-*Social Security Institution*). In the current structure of health system all patients are covered by SGK and all patients could benefit from either MoH (public) hospitals, YOK (university hospitals) or private hospitals, operating under the administration of MoH. This initiated a new era in Turkish health system while the reform and transformation processes have not been completed yet.

CHAPTER 3

LITERATURE SURVEY

Next sub section, summarizes the existing literature on DEA technique, and the following sub section summarizes the literature on Malmquist Productivity Index.

3.1. Data Envelopment Analysis (DEA)

DEA is the optimization method of mathematical programming. DEA is based on the piecewise linear convex hull approach to frontier estimation and is first proposed by Farrell (1957). DEA basically uses linear programming methods to construct a non-parametric frontier over the data set and derives efficiency measures that are calculated relative to this frontier.

Two decades following the Farrell's paper, Shephard (1970) suggested the use of mathematical programming methods that could not receive much attention in the literature until the path breaking paper of Charnes, Cooper, and Rhodes (1978) in which the term DEA was first used. Since then, the method has become very popular in the literature. In their pioneering study, they developed an input orientated model with constant returns to scale (CRS) technology to measure relative efficiencies of decision making units. Their idea was extended further through the applied studies of

Fare, Grosskopf and Logan (1983) and Banker, Charnes and Cooper (1984) in which variable returns to scale (VRS) technology is assumed.

Following those pioneering theoretical studies, great number of empirical studies has emerged. The first use of electronic computers to deal with linear programming problems was by Charnes, Cooper and Mellon (1952). In their study, they explained linear programming techniques in the context of a commercial application, namely blending aviation gasolines.

Since 1978 paper of Charnes, Cooper, and Rhodes, thousands of uses of DEA have appeared in the literature to measure efficiency in various sectors. Up to now, the DEA has been used to evaluate and compare the performances of educational departments (schools, colleges and universities), health care (hospitals, clinics) prisons, agricultural production, banking, armed forces, sports, market research, transportation, courts, benchmarking, index number construction which finally lead to the Malmquist index and many other applications. Moreover, subsequent papers has extended the use of DEA to cover dummy or categorical variables, discretionary and non-discretionary variables, incorporating value judgments, longitudinal analysis, weight restrictions, and stochastic DEA. Since there are more than thousand of empirical papers employing DEA technique, this chapter will focus on its empirical applications on the health care.

Since DEA is a non-parametric technique in its original form, it lacked statistical properties. Opponents claim that DEA efficiency estimators that come from some random data generating process are non-statistical and statistical noise caused by DEA estimators would introduce bias to estimated efficiencies. However, to remove those anomalies inherent in DEA estimators, in their challenging studies Simar and Wilson (1993, 1998, 2000b, 2005) developed various measures based on the idea of bootstrapping proposed by Efron (1979) originally. Moreover, Wilson (2008) developed a distinguished software package called *Frontier Efficiency Analysis with R* (FEAR) that incorporates the idea of bootstrapping to compute not only DEA estimates of technical, allocative and overall efficiency while assuming either variable, non-increasing or CRS but also Malmquist indices and scale efficiency measures.

All of those developments in the DEA literature attract many researchers from various fields of study and this made DEA a highly credited technique among the other alternatives in measuring the efficiency of decision making units. Increasing costs and growing demands for health care services in most of the countries raised the public concern on measuring the performance of health care providers which finally became a controversial topic debated within a great body of literature nowadays. Several econometric methods are suggested and various performance indicators are developed for performance assessment. Some of those studies employ DEA which is a very popular technique in the literature currently whereas others prefer to use different econometric approaches. Yet, studies carried out in this field are still open to improvement.

Amado and Dyson (2006) provide a detailed literature review and evaluates and compares the advantages and drawbacks of the methods used to measure the performance of primary care providers in UK. The paper, first classifies the empirical studies according to the technique used to measure performance: the ones that use Stochastic Frontier Analysis (SFA) which assumes a particular functional form for the production function and hence considered to be a parametric approach and the ones that use DEA, and then concludes that DEA has certain advantages over SFA. The study points out that if the specific functional form chosen for the stochastic production frontier does not represent the actual technology of primary care providers, the specification bias may lead to misleading efficiency measurements. On the contrary, since DEA involves the use of linear programming methods to construct a non-parametric piece-wise frontier over the data, efficiency measures that are calculated relative to this frontier will not carry a specification bias and hence will be more accurate. Hence, the paper claims that DEA could be considered as a challenging alternative to the existing methods.

Puenpatom and Rosenman (2008) are concerned with the impact of Universal Health Coverage reform in Thailand on the efficiency of health care providers. They measure the efficiency before and during the transition period by using a two-stage DEA which involves bootstrapping and truncated regressions, proposed by Simar and Wilson (2005). Input orientated model with VRS technology is assumed. In the first stage of the analysis, efficiency scores are estimated and in the second stage non-parametric, bootstrapped estimates of efficiency scores are regressed on variables that are not considered in the first stage to account for exogenous factors that might affect hospitals' performance. Their sample consists of 92 Thai public hospitals (both regional and general) observed during the period 1999-2002. In the model, inputs are defined as the number of beds, physicians, nurses, dentists and pharmacists and other personnel and outputs are defined as the adjusted number of inpatient visits in acute surgical, in primary care and in others (where adjusted inpatient number refers to the ratio of large surgeries to total surgeries times the number of inpatients in related department). Their results suggest that transformation to new health system led to an improvement in large public hospitals' efficiency, particularly in the regional ones, and that the extent of efficiency improvement differ across regions in proportion to their wealth level. Moreover, as the number of referrals from other hospitals to public hospitals increased, efficiency of both regional and general public hospitals improve.

Another study to assess the performance of hospitals is proposed by Staat (2006). In his paper, he measures the performances of hospitals in Germany based on a 1994 data by using DEA-bootstrap approach which is credited by many authors in this literature based on Simar and Wilson (1998, 2000) work. Inputs are defined as per diem rate and number of beds and outputs are defined as number of cases treated per year and reciprocal of the length of stay. He, then groups hospitals according to their respective sizes. The results of the study show that significant productivity differences exist between nearly identical hospitals and that as a result of employing bootstrapping technique which provides bias-corrected results, hospitals which are indicated as inefficient by DEA studies done so far, are actually more inefficient than they are thought to be.

Rebba and Rizzi (2006) have also compared efficiency differentials between public and private health providers in Italy using DEA approach on a data set that is composed of 85 (public and private) hospitals. As an extension to the previous studies they put specific constraints on both input and output weights. Their results reveal that, low efficiency scores, especially for public hospitals, are attributable to external factors, which are not fully controlled by the hospital management and are mainly explained by past policy-makers' decisions. According to their results, non-profit private hospitals exhibit a higher total inefficiency while both non-profit and for-profit hospitals are characterized by higher levels of scale inefficiency than public ones.

Steinmann et. al. (2004) using DEA approach, measure and compare the performances of German and Swiss hospitals by using expenses (of academic, nursing and administrative staff), patient days and number of beds as inputs; and number of cases treated (medical, pediatric, surgical, intensive) as outputs. Their study concludes that German hospitals are clearly more efficient than their Swiss counterparts and are larger in scale and size.

More currently, Bernet et al. (2008), conduct a study on efficiencies in Ukrainian polyclinics to see whether recent elections lower the efficiencies of polyclinics in eastern regions using two stage DEA procedure. However, they find that polyclinics in western Ukraine are less efficient. Possible explanations of this result are also discussed in the paper.

In addition to those studies discussed so far, Rosenman and Friesner (2004) and Kirkham and Boussabaine (2005) also studied the measurement of hospital performance based on DEA approach for USA and UK, respectively.

Apart from those, Farsi (2008) studied the temporal variation of cost efficiency in Switzerland's general hospitals by employing mixed effects model rather than DEA. The financial data used in the analysis is of 168 hospitals over the period 1998-2003. The paper constructs a cost frontier. In the model, output of any hospital is measured by the number of hospitalizations obtained through multiplying total admissions by an average cost weight calculated every year for each hospital and an amount of ambulatory services offered by the hospital. Two inputs that are considered are capital and labor and hence their prices are used as right hand side variables in the cost function. The paper concludes that there exists an increasing trend in hospitals' operating costs and the basic factor that determines hospital efficiency is the number of empty beds which indicate the existing unused capacity.

3.2. Malmquist Productivity Index

The Malmquist productivity index is used to measure and compare the productivity growth of different producing units from one period to another. Measurement is based on constructing best practice frontiers for adjacent years by using data on inputs and outputs of all producing units in the sample and then computing the output growth that is caused by shift of the frontier for each individual producing unit. What distinguishes Malmquist index from the other alternative productivity indices such as Törnquist and Fischer is that (since it is composed of distance functions) it does not require any information on prices to calculate the productivity. That is, Malmquist index is based only on quantity data and does not make any assumption on the functional form for the technology employed. Hence, Malmquist index is considered as superior to alternative indices, particularly in cases when researcher does not have any information regarding prices.

Another advantage of Malmquist index is that since it can be decomposed into two components, one which measures changes in technical efficiency (i.e. whether firms are getting closer to the production frontier over time), and one which measures changes in technology (i.e. whether the production frontier is moving outwards over time), it can provide additional insights (Bradley, 2006: 1).

Malmquist index is named after Stan Malmquist's (1953) study. The path breaking paper that was proposed by Caves et al. (1982) redefined the index as a ratio of distance functions and later, Fare et al. (1989b) showed how this index could be calculated by using non parametric linear programming methods. As a result of those successful attempts, the index has gained popularity in applied studies Based on those papers, Caves et al. (1982a, 1982b) showed how Malmquist index could be decomposed into two as efficiency change and technical change. Ray and Desli

(1997) has further decomposed Malmquist index as technical change, efficiency change and scale efficiency change. More recently, based on the inverse relationship between output distance functions and output oriented technical efficiency measures, Fare et al. (1995) proposed a method to calculate the Malmquist index relative to non parametric frontier (Borger and Kerstens, 2000: 303).

Those successful theoretical studies are followed by large number of applied studies in various fields. Up to now, Malmquist index has been applied to public sector, agriculture, banking, electric utilities, transportation, insurance companies, agriculture and countries to measure productivity.

In the literature, Malmquist index has been widely used in measuring the productivity of banking sector. In this field, the first attempt came from Berg, Forsund et al. (1992). They searched for the impacts of deregulation on the productivity of the Norwegian banks throughout 1980's. The results indicate that while the banking sector experienced a deterioration during the first years of deregulation, an improvement is observed in the following years.

Fare et al. (1994b) study the productivity growth in 17 OECD countries over the period 1979-1988 by using decomposed Malmquist productivity index obtained through nonparametric programming methods. They found that over the average productivity growth in USA is due to the technical change whereas Productivity growth in Japan which is highest in the sample, could largely be attributed to the efficiency change.

Forsund and Kittelsen (1994), applied the Malmquist index and its components to measure productivity developments in Norwegian electricity distribution utilities over the period of 1983-1989. They found that in the sector on average, there exists %2 overall productivity growth which is mainly due to the frontier technology shift.

Taskin and Zaim (1997) have also significant studies on the application of Malmquist index on comparing the performances of public and private manufacturing industries of Turkey over the period of 1974-1991 and on comparison of productivities of high and low income countries. They find that overall productivity growth of private sector is higher than that of public sector and decomposition of Malmquist index shows that although both sectors experience similar technological progresses, public sector suffers from efficiency loss hence reducing its overall productivity growth. In comparing the high and low income countries to test catching-up hypothesis, they employ Malmquist index obtained by nonparametric programming methods. The results indicate that the countries with low initial per capita income levels catch up at a faster rate whereas countries that have relatively high income depend more on technological progress for productivity increases.

Application of Malmquist index into the health sector has become a popular research field currently. One of the initial studies in the literature was Hollingsworth et al. (1998). They use DEA and Malmquist index in performance assessment and they find that public sector hospitals perform better than private ones in USA and in EU.

Roos (1997) investigate the measurement of productivity in hospital services with concentrating on eye surgeries by using Malmquist index in Sweden and discuss the alternative methods on the measurement of productivity. The paper suggests that the use of Malmquist index approach is very appropriate in cases where the service provided is complex and where it is hard to collect data on quality of the health care, health status, number of patients or visits. Their results indicate that from 1980 to 1996, overall productivity of eye surgery had increased by %25 per year.

Giuffrida (1999) proposed a study to investigate the impacts of National Health System introduced in UK in 1990. The study covers the period of 1990/91-1994/95.

Analysis is based on the Malmquist index obtained using DEA methods and decomposition of Malmquist index into its components as pure technical efficiency, scale efficiency and technological change. The results show that over the period of study, there exists small amount of productivity improvement which largely stems from the pure technical and scale efficiency improvements rather than technological and there is very limited scope for productivity gains in this sector.

In education sector, Bradley et al. (2006) used DEA based Malmquist index approach to measure the productivity of Further Education providers in England. They have 500 observations over the period of 1999-2003. Their results show that the mean provider efficiency varies between 82% and 86% over the period. Productivity change over the period is nearly 17%, and this is comprised of 10% technology change and 7% technical efficiency change.

CHAPTER 4

METHODOLOGY

This chapter describes the methodology used in this paper to measure hospital efficiency and productivity. The first sub section is devoted to present the DEA technique. The following sub section presents the methodology underlying bootstrapping technique. Finally the last sub section explains how Malmquist index is derived by using those methodologies.

4.1. DEA Technique

This brief section on DEA estimation starts with some basic definitions and notation used in the DEA literature. In a simple production technology, there exist two main variables, namely inputs and outputs. On this basis, a multi-input and multi-output production technology involving N number of inputs and M outputs could be defined as follows:

(4.1.1) $$T = \left\{ (x, y) \in R_{+}^{M+N} : x \text{ can produce } y \right\}$$

where $x = (x_1, ..., x_N) \in R_{+}^{N}$ represents vector of inputs and $y = (y_1, ..., y_M) \in R_{+}^{M}$ represents the vector of outputs. Intuitively, production set T consists of all combinations of inputs and outputs such that x can produce y.

Production technology could equivalently be represented by output set (also known as production possibility set) which is defined as:

(4.1.2) $$P(x) = \left\{ y \in R_+^M \, : \, (x, y) \in T \right\}$$

Output set is assumed to satisfy:

- Strong disposability of outputs (and of inputs)

  if $y^* \in P(x)$ and $y \le y^* \rightarrow y \in P(x)$

- Possibility of inaction (i.e. nothing can be produced from given set of inputs)

  $0 \in P(x)$

- Non zero output levels cannot be produced from zero levels of inputs

  $P(0) = \{0\}$

- $P(x)$ is compact (i.e. closed and bounded) That's, given finite amount of inputs, only finite amount of outputs could be produced.

- $P(x)$ is convex

  if $y_1, y_2 \in P(x)$ then $\left\{ \alpha y_1 + (1-\alpha) y_2 \right\} \in P(x)$ where $\alpha \in [0,1]$

  In other words, if two combinations of output levels can be produced with a given input vector x, then any weighted average of these output vectors can also be produced.

Given the notation presented above, we now move on the definition of output (input) distance function which is very useful tool in describing the technology in such a way that it enables us to measure efficiency and productivity in a reliable manner. Distance function is simply based on radial contractions and expansions. Malmquist (1953) and Shephard (1953) introduced this notion, independently in their own studies. The advantage of using distance functions is that it allows to define multi input and multi output production technology without the need to specify a behavioral objective such as cost minimization or profit maximization (Coelli et al., 2005: 47). A researcher could either use input or output distance functions depending on the objective of the analysis. Particularly, input distance function concentrates on the idea of minimal proportional contraction of the input vector, given the output vector whereas output distance function concentrates on the idea of maximal proportional expansion of the output vector, given the input vector. Since input and output distance functions are analogous, in this chapter only the output distance function is defined. Hence, given the input vector, one can define the output distance function as follows:

(4.1.3) $$D_O(x, y) = \min\{\, \mu : (y/\mu) \in P(x) \,\}$$

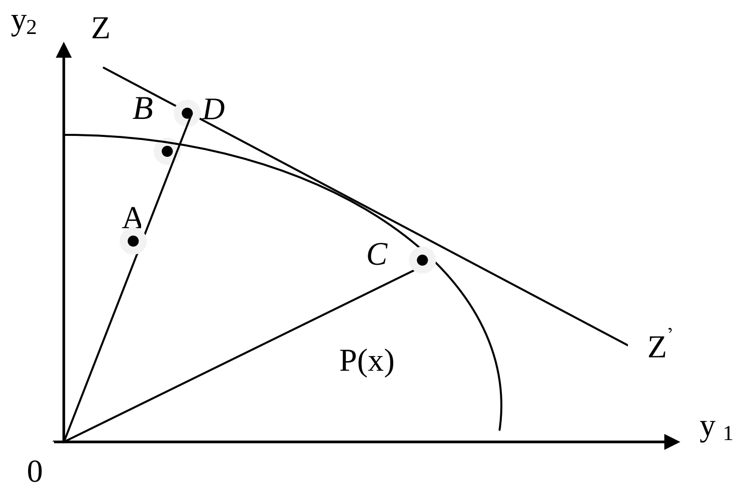
where $0 \le D_O(x, y) \le 1$. The basic properties of output distance function that follow from the assumptions on output set $P(x)$ discussed above are*:

- $D_O(x,0) = 0$ for all non negative x
- Non decreasing in y and non increasing in x
- Linearly homogenous in y
- Quasi-convex in x and convex in y

To illustrate the idea of output distance function, see the figure 4.1.1. below:

* See Fare and Primont (1995) for proofs and derivations of these properties.

Figure 4.1.1. Production Possibility Set and Output Distance Function



To illustrate, in Figure 4.1.1. there are three firms (i.e. observations) each using one unit of input to produce two different outputs, y_1 and y_2. Given the production possibility set which is the area bounded by production possibility frontier and axes, the value of the output distance function for firm A equals to the ratio $\mu = OA/OB$. In this setting, firm B constitutes the reference technology for firm A. By using one unit of input, firm B can produce more than firm A. Thus, given the input, firm A is inefficient by an amount of μ. In other words, to become efficient firm A should proportionally expand its production of both outputs by a fraction of $1/\mu$ and it can still remain within the production possibility frontier. Thus, the value of distance function is the reciprocal of the factor by which the production of all output quantities could be increased while still remaining in the production possibility set. Moreover, since firms B and C are on the boundary of the set, they are the benchmark firms and the value of their distance functions equal to 1 which implies that those are fully efficient firms.

Now we are equipped with enough tools to describe and measure the efficiency concept. The following discussion begins with Farrell's (1957) ideas of input and output oriented technical efficiency measures[*]. On this basis, Farrell first decomposes overall economic efficiency as technical efficiency and allocative efficiency and then he further decomposes technical efficiency as scale efficiency and pure technical efficiency. To illustrate the idea, again refer to the figure 4.1.1. If we have information on prices, then we can draw the iso revenue line ZZ', and define the Farrell's measure of allocative efficiency as OD/OB i.e. the ratio of maximum feasible revenue to the revenue earned at the reference technology. Similarly, Farrell defines output oriented technical efficiency as OB/OA i.e. the ratio of maximum potential output (at B) to actual or observed output (at A). Finally, overall measure of output efficiency which is sometimes referred as revenue measure of output efficiency is defined as OD/OA. Now, it is easy to see the relationship between allocative, technical and overall efficiency:

$$OD/OA = (OD/OB) \times (OB/OA)$$

In other words,

Overall Efficiency = Allocative Efficiency × Technical Efficiency

More particularly, output oriented technical efficiency measure basically deals with how much outputs could be proportionally expanded without changing the input quantities used. In other words:

(4.1.4) $$F_O(x, y) = \max\left\{ \theta : \theta y \in P(x) \right\}$$

which is called as *Farrell Output Oriented Measure of Technical Efficiency.*

At this stage, it is important to notice the inverse relationship between output distance function $D_O(x, y)$ and Farrell output oriented technical efficiency measure

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[*] Although there exists input and output oriented technical efficiency measures, this section only provides the discussion on output oriented measures. Note that they are equivalent measures only if CRS technology exists. For further discussion on this, see Fare and Lovell (1978).

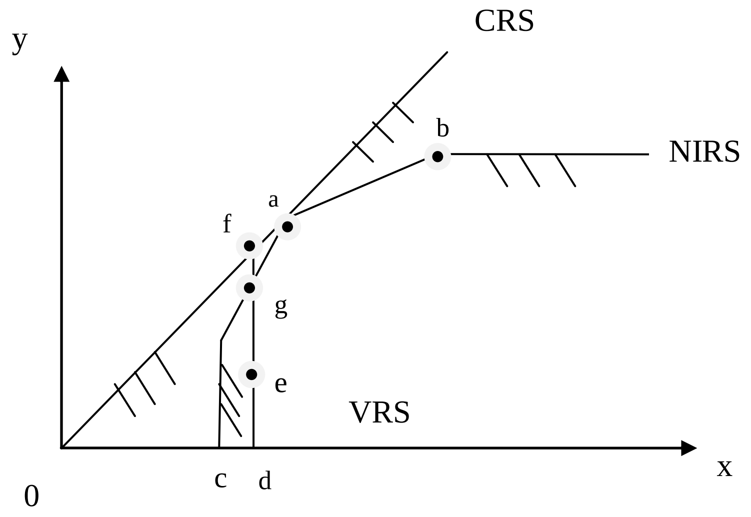
$F_O(x,y)$. Formally, equations (4.1.3) and (4.1.4) together imply that:

(4.1.5) $$F_O(x,y) = (D_O(x,y))^{-1} \Leftrightarrow \theta = 1/\mu$$

So, $F_O(x,y) \geq 1$ that directly follows from the $0 \leq D_O(x,y) \leq 1$. Hence, unlike output distance function, the value of Farrell output oriented technical efficiency measure which is equal to 1 indicates a fully efficient firm whereas a value above 1 indicates an inefficient firm by an amount above 1.

Choice of appropriate measure to calculate the efficiency is not the end of the story. Since it is possible to have firms that are efficient both technically and allocatively but that are not operating at an optimal scale, one should also be careful in choosing the appropriate returns to scale technology that will be applied to the analysis. Efficiency could either be estimated assuming CRS, VRS or non increasing returns to scale (NIRS) technology. However, the CRS assumption holds when all firms are operating at an optimal scale, but this becomes very unrealistic when imperfect competition, government regulations, constraints on finance etc. are considered. Moreover, when not all firms are operating at an optimal scale, assuming CRS, results in technical efficiency measures confounded by scale efficiencies (Coelli et al., 2005: 172). Hence, in such cases, it would be more appropriate to assume VRS yielding technical efficiency estimates that are free of scale efficiency effects. Another advantage of VRS specification is that this approach forms a convex hull of intersecting planes that envelope the data points more closely than the CRS and NIRS conical hull. To see this, consider the figure 4.1.2. in which one input (x) and one output (y) production technology is depicted with respect to the CRS, NIRS and VRS assumptions:

Figure 4.1.2. CRS, NIRS and VRS Frontiers and Scale Efficiency Mesurement



As it can be inferred from the figure, under CRS technology, proportional changes in outputs require proportional changes in inputs, whereas under NIRS technology, to scale up outputs, inputs should be scaled up by a larger amount. In figure 4.1.2. CRS technology is bounded by the x-axis and the ray trough point a. NIRS that does not allow for outward scaling but that allows for convex combinations of existing observations and the origin is bounded by the line segments *Oa, ab,* the horizontal extension from b, and the x-axis. Finally, VRS that allows only convex combinations of existing observations, is bounded by the x-axis starting from point c, and the line segments ca, ab and the horizontal line emanating from point b. On this basis, according to Figure 4.1.2, Farrell output oriented technical efficiency score relative to CRS technology equals $F_O^{CRS} = df/de$ whereas efficiency score relative to VRS technology equals $F_O^{VRS} = dg/de$. Thus, scale efficiency is given by $SE = df/dg$. Therefore, it can be concluded that:

(4.1.6.) $$SE = F_O^{CRS} / F_O^{VRS}$$

which measures the deviations from CRS technology in the output direction.

Thus, an observation is said to be scale efficient if $SE = 1$(i.e. $F_O^{CRS} = F_O^{VRS}$). And scale inefficient, if $SE > 1$, by an amount above 1.

So far, required notation and theory underlying the DEA technique is discussed. Now, we are ready to formulate the DEA model that is used in this paper. Throughout the analysis, VRS technology is assumed because of the reasons explained above. Assume that there exist $k = 1,...K$ observations in the sample. Hence, given our data set and assumptions on output set presented so far, for VRS specification, an output set that holds for every period and for all observations can be constructed in the following way:

(4.1.7)
$$P(x) = \left\{ y \in R_+^M : \sum_{k=1}^{K} z_k y_{km} \geq y_m \; ^{\square} \qquad m = 1,...M \right.$$
$$\sum_{k=1}^{K} z_k x_{kn} \leq x_n \qquad n = 1,...N$$
$$z_k \geq 0 \qquad k = 1,...K$$
$$\left. \sum_{k=1}^{K} z_k = 1 \right\} ^{\Diamond}$$

where z_k 's stand for the intensity variables (weights) assigned to each observation while constructing the production set. Thus, given the production set and constraints specified above, the linear programming problem solved by DEA (i.e. output oriented VRS DEA model) for each k, would be as follows:

□ It is the direct consequence of strong disposability of outputs. For a detailed discussion see Fare and Grosskopf (1998-2000).

◊ Convexity constraint that imposes the VRS assumption . It ensures that an inefficient firm is only benchmarked against firms of a similar size. That's, the projected point for that firm on the DEA frontier is a convex combination of observed firms.

(4.1.8) $$\theta_k^* = F_O(x,y) = \max_{\theta,z}\left\{ \theta : \sum_{k=1}^{K} z_k y_{km} \geq \theta y_m \qquad m = 1,...M \right.$$

$$\sum_{k=1}^{K} z_k x_{kn} \leq x_n \qquad n = 1,...N$$

$$z_k \geq 0 \qquad k = 1,...K$$

$$\left. \sum_{k=1}^{K} z_k = 1 \right\}$$

where $1 \leq \theta \leq \infty$. Note that, θ^* is the feasible proportional increase in outputs that could be achieved by the k*th* observation, if the given inputs were used efficiently. So, this linear programming problem should be solved for each observation in the sample, separately. Hospitals efficiencies are evaluated in terms of their $F_O(x,y)$ scores. Hence, smaller the $F_O(x,y)$, the better the performance of that hospital.

4.2. Bootstrapping

In the literature, it is argued that the efficiency estimates obtained from the DEA procedure described in the previous section would be biased upwards. In the context of DEA, since the best practice frontier is constructed on the basis of the sample in hand, the results would become very sensitive to sample selection. In such cases, bias arises when there exist efficient firms (i.e. hospitals) that are not contained in the sample. Thus, the observed efficiency scores of inefficient firms calculated on the basis of what is observed is an upward biased estimate of their true efficiency (Staat, 2006: 2259). Since the possibility of having unobserved but efficient firms is very high, the original efficiency scores obtained from DEA procedure would be biased. Up to now, to overcome this bias, various measures are developed by several authors such as Banker (1993), Korostelev *et. al.* (1995) and Kneip *et.al.* (1998).

More recently, in their 1998 and 2000 papers, for multi-input and multi-output model, Simar and Wilson suggested the use of bootstrapping technique which was originally developed by Efron (1979) to analyze the sensitivity of the efficiency measures to sampling variations* and to correct the bias of DEA estimators. This influential work, made bootstrapping highly credited technique that is used to obtain bias corrected efficiency scores.

To begin with, suppose a data generating process (DGP), φ generating a random sample of:

(4.2.1.) $$S = \{ (x_k, y_k) : k = 1,...K \}$$

By some method *M*, this sample defines estimators of T and $P(x)$ discussed in the previous section, namely $\hat{T}$ and $\hat{P(x)}$. Given those, for k*th* observation, the output oriented technical efficiency score at point (x_k, y_k) can be calculated as follows:

(4.2.2) $$\hat{\theta}_k = \max\{\theta : \theta y \in \hat{P(x)} \}$$

which is the estimator of the true but unobserved population efficiency score θ_k. The problem is that sampling distributions of $\hat{T}$ and $\hat{P(x)}$ could not be inferred because φ is unknown and the complexity of *M* makes it almost impossible to determine it. However, bootstrapping technique which is based on the idea that there exists a consistent estimator of , φ namely $\hat{\varphi}$, enables us to obtain consistent estimators of T and $P(x)$, even though φ is unknown.

Now, suppose that, given the sample S, by using our knowledge, we can produce a consistent estimator of φ namely, $\hat{\varphi}$. Then, consider another sample S^* which is generated by $\hat{\varphi}$ through random resamplings with replacement from S.

* For more theoretical and detailed discussion of bootstrapping, see Simar and Wilson (1998,2000)

Formally,

(4.2.3) $$S^* = \left\{ (x_k^*, y_k^*) : k = 1,...K \right\}$$

Similar to S, by some method *M*, this pseudo sample also defines corresponding estimators of T and P(x) that are $\hat{T}^*$ and $\hat{P}(x)^*$ respectively. Thus, for any pair of (x_k^*, y_k^*), the corresponding output oriented technical efficiency score is given by:

(4.2.4) $$\hat{\theta}_k^* = \max\left\{ \theta : \theta y \in \hat{P}(x)^* \right\}$$

Expression (4.2.4) could equivalently be defined as a linear programming problem:

(4.2.5) $$\hat{\theta}_k^* = \max_{\theta,z} \left\{ \theta : \sum_{k=1}^{K} z_k y_{km}^* \geq \theta y_m \qquad m = 1,...M \right.$$

$$\sum_{k=1}^{K} z_k x_{kn}^* \leq x_n \qquad n = 1,...N$$

$$z_k \geq 0 \qquad k = 1,...K$$

$$\left. \sum_{k=1}^{K} z_k = 1 \right\}$$

In this case, however, since the underlying DGP, $\hat{\varphi}$ is already known, the sampling distributions of the estimators $\hat{T}^*$ and $\hat{P}(x)^*$ are completely known, although it may be difficult to estimate analytically. Nevertheless, the sampling distributions could easily be approximated by Monte Carlo methods. The steps of the approximation can be summarized as follows:

1. Use $\hat{\varphi}$ to generate B number of pseudo samples such that S_b^*, where $b = 1,...B.$
2. Apply *M* to each of those samples and obtain the estimators $\hat{T}^*$ and $\hat{P}(x)^*$ for $b = 1,...B.$
3. Obtain $\hat{\theta}_{kb}^*$ for each k, where $k = 1,...K$ and $b = 1,...B.$

This procedure allows us to estimate the empirical density function of $\{\hat{\theta}_{kb}^{*}\}_{b=1}^{B}$ which is nothing more than the Monte Carlo approximation of the distribution of $\hat{\theta}_{kb}^{*}$ conditional on $\hat{\varphi}$. Intuitively, by repeatedly simulating or mimicking the DGP through resampling with replacement and through applying the original estimator to each simulated sample, we could approximate the sampling distributions of the original estimator.

Given the assumption* that $\hat{\varphi}$ is a consistent estimator of φ, the bootstrap method concludes that the known bootstrap distributions obtained by the procedure described above will mimic the original unknown sampling distributions of the estimators of interest (Simar and Wilson, 1998: 51)**. More formally,

(4.2.6) $$\left(\hat{\theta}_k^{*} - \hat{\theta}_k\right) \mid \hat{\varphi} \;\sim\; \left(\hat{\theta}_k - \theta_k\right) \mid \varphi$$

That's to say, *within the true world,* $\hat{\theta}_k$ is an estimator of θ_k based on the sample S, generated from some DGP, φ whereas, *in the bootstrap world,* $\hat{\theta}_k^{*}$ is an estimator of $\hat{\theta}_k$ based on the sample S^* generated from $\hat{\varphi}$. Then, if bootstrap is consistent (i.e. if $\hat{\varphi}$ is a consistent estimator of φ), the known bootstrap distributions will duplicate the original and unknown sampling distributions of the estimators (Simar and Wilson, 2000: 61). Indeed, the expression in (4.2.6) constitutes the most crucial result of bootstrapping technique. By applying this result, not only the bias of $\hat{\theta}_k$ (which is the estimator of θ_k) could be estimated but also, it enables us to estimate other statistical properties such as standard errors, variance and confidence intervals that eventually allows us to test hypothesis based on those estimates. On this basis, we can estimate:

* See Hall (1992).
** For more detailed discussion and derivations, see Simar and Wilson (1998, 2000).

(4.2.7) $$bias_{\varphi,k} = E_{\varphi}\left(\hat{\theta}_k\right) - \theta_k$$

by using its bootstrap estimate given by:

(4.2.8) $$bias_{\hat{\varphi},k} = E_{\hat{\varphi}}\left(\hat{\theta}_k^*\right) - \hat{\theta}_k$$

which could be approximated by Monte Carlo realizations $\hat{\theta}_{kb}^*$:

(4.2.9) $$b\hat{i}as_k = \frac{1}{B}\sum_{b=1}^{B}\hat{\theta}_{kb}^* - \hat{\theta}_k = \overline{\theta}_k^* - \hat{\theta}_k \qquad \text{for } b = 1,...B$$

Thus, bias corrected estimator of $\hat{\theta}_k$ is given by:

(4.2.10) $$\tilde{\theta}_k = \hat{\theta}_k - b\hat{i}as_k = 2\hat{\theta}_k - \overline{\theta}_k^*$$

The standard error of $\hat{\theta}_k$ can be estimated by:

(4.2.11) $$s\hat{e} = \left\{ \frac{1}{B-1}\sum_{b=1}^{B} \left(\hat{\theta}_{kb}^* - \overline{\theta}_k^*\right)^2 \right\}^{1/2}$$

The confidence interval for θ_k for some values a_α and b_α given by:

(4.2.12) $$Prob\left\{-b_\alpha \le \left(\hat{\theta}_k - \theta_k\right) \le -a_\alpha \right\} = 1-\alpha$$

can easily be calculated by using its bootstrap estimate for some bootstrap values a_α^* and b_α^*,which is given by:

(4.2.13) $$Prob\left\{-b_\alpha^* \le \left(\hat{\theta}_{kb}^* - \hat{\theta}_k\right) \le -a_\alpha^* \;\middle|\; S^* \right\} = 1-\alpha \qquad \text{for } b = 1,...B$$

substituting a_α^* and b_α^*, for a_α and b_α in (4.2.12) combined with (4.2.13) leads to the bootstrap approximation:

(4.2.14) $$Prob\left\{ -b_\alpha^* \le \left(\hat{\theta}_k - \theta_k\right) \le -a_\alpha^* \;\middle|\; S^* \right\} \approx 1-\alpha$$

Therefore,

(4.2.15) $$\hat{\theta}_k + a_\alpha^* \le \theta_k \le \hat{\theta}_k + b_\alpha^*$$

4.3. Malmquist Productivity Index

This section presents the theory underlying Malmquist index in the light of distance functions and bootstrapping discussed in the previous sections. Currently, there exists input and output oriented Malmquist indices that were introduced by Cave et al. (1982) and that are composed of Shephard (1970) input and output distance functions discussed in section 4.1, respectively[*].

Following Fare et al. (1994), output oriented Malmquist productivity index based on output distance functions is defined by[**]:

$$(4.3.1) \qquad M_O\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left[\frac{D^t_{O,CRS}\left(x^{t+1}, y^{t+1}\right)}{D^t_{O,CRS}\left(x^t, y^t\right)} \times \frac{D^{t+1}_{O,CRS}\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}_{O,CRS}\left(x^t, y^t\right)} \right]^{1/2}$$

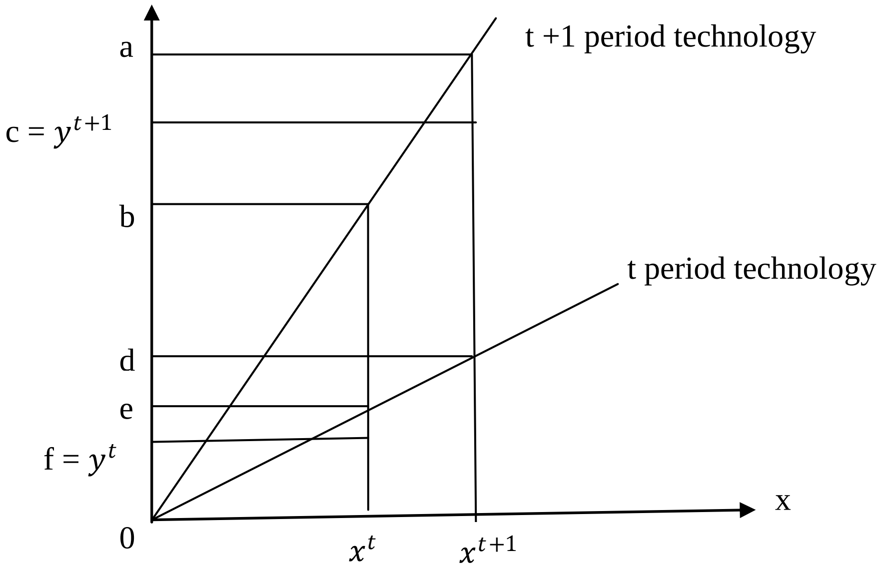
It may be helpful to illustrate the output oriented Malmquist productivity index on a figure. In figure 4.3.1 below, two technologies are involved, one for period t and the other for period t+1. Given the figure, productivity change for input-output vectors (x^t, y^t) and (x^{t+1}, y^{t+1}) based on y-distances (since this is an output oriented measure) is given by:

$$(4.3.2) \qquad M_O\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left[\frac{Oc/Od}{Of/Oe} \times \frac{Oc/Oa}{Of/Ob} \right]^{1/2}$$

[*] In this section, to conserve space, only the output oriented Malmquist index is discussed. Input oriented Malmquist index involves a straightforward translation of the notation in the following discussion.

[**] $D_0^{t+1}(x^t, y^t)$, for example, measures the distance of firm at time t relative to the frontier at time t+1. Thus, the superscript on the distance function denotes the reference technology whereas superscripts on inputs and outputs denote the time period under consideration.

Figure 4.3.1. Output Oriented Malmquist Productivity Index



Malmquist index can be decomposed into two different components, namely efficiency change (MEFFCH) and technical change (MTECH) defined as:

(4.3.4)
$$MEFFCH_t^{t+1} = \frac{D_{O,CRS}^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_{O,CRS}^{t}\left(x^{t}, y^{t}\right)}$$

(4.3.5)
$$MTECH_t^{t+1} = \left[\frac{D_{O,CRS}^{t}\left(x^{t+1}, y^{t+1}\right)}{D_{0,CRS}^{t+1}\left(x^{t+1}, y^{t+1}\right)} \times \frac{D_{O,CRS}^{t}\left(x^{t}, y^{t}\right)}{D_{O,CRS}^{t+1}\left(x^{t}, y^{t}\right)}\right]^{1/2}$$

Equation (4.3.1) combined with (4.3.4) and (4.3.5), together imply that:

(4.3.6)
$$M_t^{t+1} = MEFFCH_t^{t+1} \times MTECH_t^{t+1}$$

The first component measures the change in technical efficiency between time t and t+1, and hence whether the production is getting closer to the best practice frontier for all observations in the sample (Taskin and Zaim, 1997: 95). The second component shows the shift in frontier between time t and t+1. Overall, index values greater than one indicates improvement in productivity whereas values less than one indicates deterioration in productivity. In figure 4.3.1, efficiency change and technical change components can be defined as:

(4.3.7) $$MEFFCH_t^{t+1} = \frac{Oc/Oa}{Of/Oe}$$

(4.3.8) $$MTECH_t^{t+1} = \left[\frac{Oa/Od}{Ob/Oe}\right]^{1/2}$$

However, Fare et al. (1994) further decomposed (4.3.4) as pure efficiency change and scale efficiency change defined by:

(4.3.9) $$PUREEFFCH_t^{t+1} = \frac{D_{O,VRS}^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_{O,VRS}^{t}\left(x^{t}, y^{t}\right)}$$

(4.3.10) $$SCALEEFFCH_t^{t+1} = \frac{D_{O,CRS}^{t+1}\left(x^{t+1}, y^{t+1}\right) / D_{O,VRS}^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_{0,CRS}^{t}\left(x^{t}, y^{t}\right) / D_{O,VRS}^{t}\left(x^{t}, y^{t}\right)}$$

Hence, (4.3.9) and (4.3.10) combined with (4.3.6) implies that,

(4.3.11) $$M_t^{t+1} = PUREEFFCH_t^{t+1} \times SCALEEFFCH_t^{t+1} \times MTECH_t^{t+1}$$

As noted earlier, the advantage of using Malmquist index is that unlike alternative indices, it does not require any information on prices of inputs or outputs. However, similar to DEA estimators, Malmquist index is also obtained by non parametric DGP based on the estimation of true but unobserved best practice frontier conditional on the sample in hand and this makes estimated Malmquist indices very sensitive to sample selection bias, too. Hence, to remove this bias, based on their 1998 paper, Simar and Wilson (1999) suggested applying bootstrapping technique to Malmquist indices. The procedure is similar to the one explained for DEA estimators[*]. In this context, bootstrapping technique provides confidence intervals for Malmquist indices that enable us to assess whether productivity changes as measured by the Malmquist index are significant in a statistical sense. If it is significant, then the results imply a real change in productivity, otherwise it should be considered as nothing more than a trick of sampling noise.

[*] For theory and methodology of estimating and bootstrapping Malmquist indices, see Simar and Wilson (1999).

CHAPTER 5

DATA, EMPIRICAL RESULTS AND DISCUSSION

This chapter first describes the data used in this study. Then, the following sub sections present the results obtained from application of the data and comparisons of DEA efficiency scores and Malmquist index scores for hospitals in the sample. Final sub section is devoted to the evaluation of the reform.

5.1. The Data

The source of the data used in this paper is the national hospital statistics data of the *Republic of Turkey, Ministry of Health.* The complete MoH data set contains observations on approximately 1150 hospitals (public, private, SSK, and university) that provide not only outpatient care, but also inpatient care during the period 2001-2007 (i.e. the period before and after the reform).

The data available for each hospital includes the type of ownership (MoH including the university hospitals, SSK and private), number of beds, hemodialysis equipment, amount of blood stock, number of physicians (specialist and practitioner), outpatients, number of outpatient visits per physician, inpatients (discharged and death), total patient days, number of surgical operations (big, middle, small), number of births, and information on evaluation of services (bed occupation rate, average length of stay, speed of discharge from bed, unemployed period for bed and the rate of stayed patient).

Since an adequate efficiency analysis requires a sample of comparable hospitals, first of all, the hospitals specialized in just one field of medicine such as mother and child health care, physiotherapy and rehabilitation, mental disorders, eye care, oncology, cardiology, urgent care and traumatology are eliminated. As a result, we are left with 744 hospitals in the pre-reform period and 714 hospitals in the post reform period (due to the mergers), providing health care services ranging from primary health care to specialized inpatient and outpatient care in various fields of medicine.

Although the data provide detailed information on hospitals, not all hospitals could be followed incessantly during the period of 2001-2007. For instance, some began to operate in 2002 whereas some in 2004. So, to obtain a balanced panel data, those hospitals which are not common over 2001-2007 periods are eliminated. Moreover, hospitals that have missing data are excluded from the analysis.

Finally, we end up with a balanced panel of 441 hospitals (281 MoH, 85 SSK, 45 university and 30 private hospitals) in the pre-reform period and 415 hospitals (338 MoH, 47 university and 30 private hospitals) in the post-reform period due to the mergers and turnovers. It is important to note that to get valid results, only hospitals with a very similar structure and very similar facilities should be compared. The final version of our sample that consists of nearly identical hospitals in scale and in size guarantees a tractable and homogeneous data set over the period of 2001-2007.

The DEA model used in this study includes three inputs and six outputs. Inputs are defined as number of existing beds representing the capital required to produce output, number of specialists (SPECIA) and number of practitioners (PRACT) representing the labor required for production. Outputs are defined as outpatient visits (OUTPAT), number of small (SURG-SM), medium (SURG-MD) and big (SURG-BIG) surgeries separately, number of births and total inpatient days (TID).

Table 5.1.1. Descriptive Statistics: Mean (Standard Deviation) per year

YEAR	OUTPAT	SURG-BIG	SURG-MD	SURG-SM	BIRTHS	TID	BEDS	SPECIA	PRACT
2001	214955,22 (298720,14)	1447,52 (2414,75)	1076,73 (1340,87)	587,70 (1219,75)	1020,33 (1332,30)	50034,88 (68392,25)	208,77 (259,69)	49,68 (77,19)	37,51 (90,81)
2002	220399,14 (235250,36)	1592,01 (2703,59)	1116,81 (1415,20)	684,09 (1539,19)	906,12 (1135,58)	52287,07 (70842,78)	211,82 (260,34)	52,34 (80,39)	39,65 (95,67)
2003	229076,81 (240049,62)	1811,91 (2860,64)	1070,55 (1388,82)	791,21 (2157,04)	892,09 (1141,68)	53829,12 (72888,00)	215,96 (257,69)	55,05 (85,40)	40,25 (93,51)
2004	258579,77 (255326,19)	2268,04 (3249,63)	1227,26 (1666,85)	1026,48 (3044,90)	877,55 (1067,25)	58062,62 (76239,64)	223,53 (272,53)	58,56 (95,03)	42,60 (98,60)
2005	321286,19 (315909,07)	2870,06 (3912,31)	1427,94 (2172,73)	1391,86 (3501,86)	893,51 (1124,98)	61136,18 (81647,78)	239,75 (277,17)	61,49 (91,52)	48,57 (115,26)
2006	365236,85 (353134,60)	3228,41 (4505,66)	1684,92 (2911,19)	2079,97 (6369,73)	875,69 (1174,21)	62941,21 (82569,36)	252,52 (283,44)	63,72 (100,28)	50,01 (112,83)
2007	397009,21 (361335,91)	3424,44 (4497,33)	1966,18 (3001,91)	2563,45 (7043,89)	1423,76 (8750,47)	60884,57 (80005,36)	228,70 (253,03)	65,52 (110,87)	52,09 (117,23)

Table 5.1.1. provides sample means and standard deviation of all DEA variables by year. Output variables are continuously increasing over the period of 2001-2007, except the number of births that declines in 2007 and that may be due to the effects of birth controls. On the other hand, we observe sharp rises in the number of surgeries and outpatients from 2003 to 2004 and from 2004 to to 2005, as the first steps of the reform were introduced. Moreover, from 2003 onwards outpatients treated in MoH hospitals has increased whereas those treated in SSK hospitals has decreased, reflecting the shift of excess burden on SSK hospitals towards MoH hospitals as rationing of patients with respect to membership is alleviated (see Appendix A Figure 5.1.1. and Figure 5.1.2.) Input variables also follow an increasing

trend over 2001-2007. Moreover, in all years number of specialists is greater than the number of practitioners.

5.2. Empirical Results and Discussion

To obtain empirical results output oriented DEA model under the assumption of VRS and output oriented Malmquist Productivity index are used as formulated in methodology described in chapter 4. All the computational work is done by software package *Frontier Efficiency Analysis with R (FEAR) 1.11* developed by Wilson (2008)[*]. What distinguishes FEAR from the alternative software packages like DEAP or STATA is that it permits to estimate not only non parametric DEA estimates of technical, allocative, scale and overall efficiency (while assuming either CRS, NIRS or VRS) and Malmquist indices but also it permits to estimate bootstrapped (i.e. bias corrected) counterparts of them which enables us to do statistical inference based on those findings. In the first sub section of this part, application of the methods and estimated efficiency scores of hospitals are discussed whereas in the second sub section, application and estimated Malmquist index scores of hospitals are discussed.

5.2.1. Application and Comparison of Output Oriented Farrell Efficiency Scores

To evaluate the results, first of all, hospitals are grouped according to their ownership type, namely MoH (i.e. public hospitals), SSK, university and private hospitals. However, to follow the impacts of the reform on hospitals more closely, MoH hospitals are further divided into two subgroups: MoH (merged), represents the MoH hospitals that will be merged with the SSK hospitals under the supremacy of MoH in the year 2005, whereas MoH (independent), represents the MoH hospitals that

[*] For further discussion on FEAR, see FEAR 1.11 Command Reference or User Guide, Wilson (2008)

remain the same both administratively and managerially, in the pre and post reform periods. Similarly, SSK hospitals are further divided into two subgroups: SSK (merged), represents the ones that will be attached to the corresponding MoH (merged) hospitals under the rule of MoH, in 2005 and they are completely abolished thereafter whereas SSK (revolved) hospitals, represents the ones that will be transferred from ownership of SSK to that of MoH administratively but not managerially, in 2005 due to the reform.

On this basis, we first estimate the efficiency scores obtained through the ordinary DEA model for each type of hospital and then efficiency scores are re-estimated by using bootstrapping method which allows a deeper assessment of efficiency. The geometric means of estimated efficiency scores (with and without bootstrapping) for each type of hospital are given in Table 5.2.1.1 below:

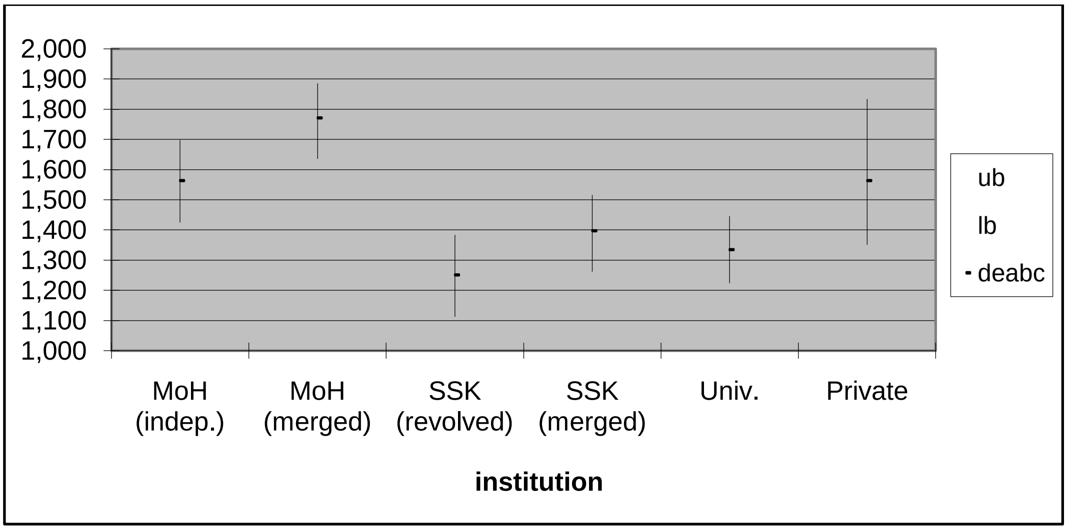
Table 5.2.1.1. Comparison of DEA and Bootstrap Efficiency Scores, 2001-2007

	2001		**2002**		**2003**		**2004**		**2005**		**2006**		**2007**	
Institution	DEA	**DEA***	DEA	**DEA***	DEA	**DEA***	DEA	**DEA***	DEA	**DEA***	DEA	**DEA***	DEA	**DEA***
MoH (merged)	1.619	1.771	1.631	1.782	1.716	1.863	1.442	1.574	1.451	1.610	1.270	1.370	1.244	1.445
MoH (indep.)	1.410	1.564	1.428	1.595	1.482	1.649	1.343	1.486	1.401	1.576	1.282	1.401	1.352	1.475
SSK (revolved)	1.102	1.251	1.099	1.260	1.121	1.297	1.215	1.364	1.357	1.533	1.163	1.267	1.137	1.243
SSK (merged)	1.250	1.397	1.280	1.437	1.316	1.475	1.430	1.581	-	-	-	-	-	-
Univ.	1.213	1.335	1.319	1.483	1.192	1.326	1.170	1.301	1.260	1.430	1.184	1.299	1.107	1.210
Private	1.338	1.564	1.371	1.624	1.393	1.648	1.369	1.583	1.260	1.486	1.266	1.448	1,219	1.394
OVERALL	1.338	1.492	1.363	1.534	1.390	1.560	1.317	1.464	1.370	1.548	1.251	1.370	1,277	1,398

In the table, in each year, the first column shows ordinary DEA efficiency scores denoted by DEA whereas the second column shows bootstrapped (i.e. bias corrected) efficiency scores denoted by **DEA***. Moreover, it is important to note that since we use the output oriented Farrell measure of efficiency which estimates output oriented radial expansion factors to calculate efficiency scores, the smaller the efficiency score the better the performance of that hospital. The results show that hospitals which are indicated as inefficient by the ordinary DEA procedure are actually more inefficient than it is thought to be due to the bias inherent in ordinary DEA scores. However, there exist significant improvements in the overall efficiencies of hospitals in 2006 and in 2007 compared to 2001.

An advantage of bootstrapping is that, as mentioned earlier, it predicts the efficiency scores within a given confidence interval which enables us to do statistical inferences. On this basis, Figure 5.2.1.1* which shows confidence interval widths for bias corrected efficiency scores of 2001 suggests that SSK hospitals are significantly more efficient than MoH hospitals in the year 2001. (a finding which is also supported by Table 5.2.1.1)

Figure 5.2.1.1. Confidence Intervals for Bias Corrected Efficiency Scores of 2001

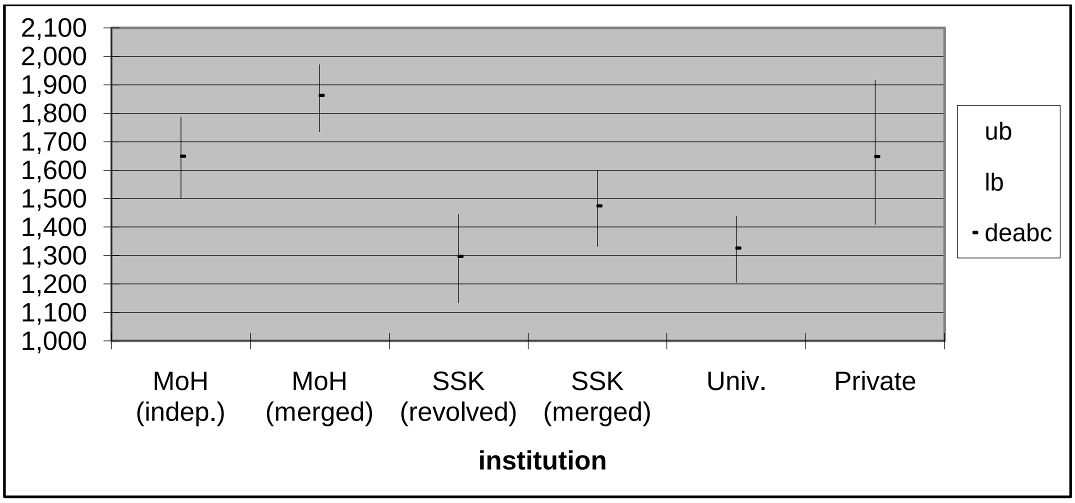


* In the following figures, ub stands for upper bound of the confidence interval whereas lb stands for lower bound and deabc denotes the bias corrected DEA efficiency score.

Furthermore, it also suggests that the efficiency differentials among institutions of different type are statistically significant. It is very reasonable to obtain those results because approximately %60 of population (an amount corresponding to 32 million people) was covered by SSK and SSK hospitals were obliged to deliver heath care services to all those 32 million people (later increased to 45 million) and this fact eventually led SSK hospitals to deliver more outputs (number of outpatients, inpatient days, births and surgeries) relative to MoH hospitals, given the same amount of nearly identical inputs with that of MoH, hence making SSK hospitals relatively more efficient. Indeed, this result shows the extent of overcrowding in SSK hospitals that operated over capacity permanently. Hence, the reform should be such that it should distribute the excess burden on SSK hospitals towards other institutions The trends for the year 2002 suggests that the significant efficiency differentials among institutions increased and bias corrected efficiency scores of all type of institutions deteriorated, except with an improvement in efficiency score of university hospitals (see Appendix B Figure 5.2.1.2.).

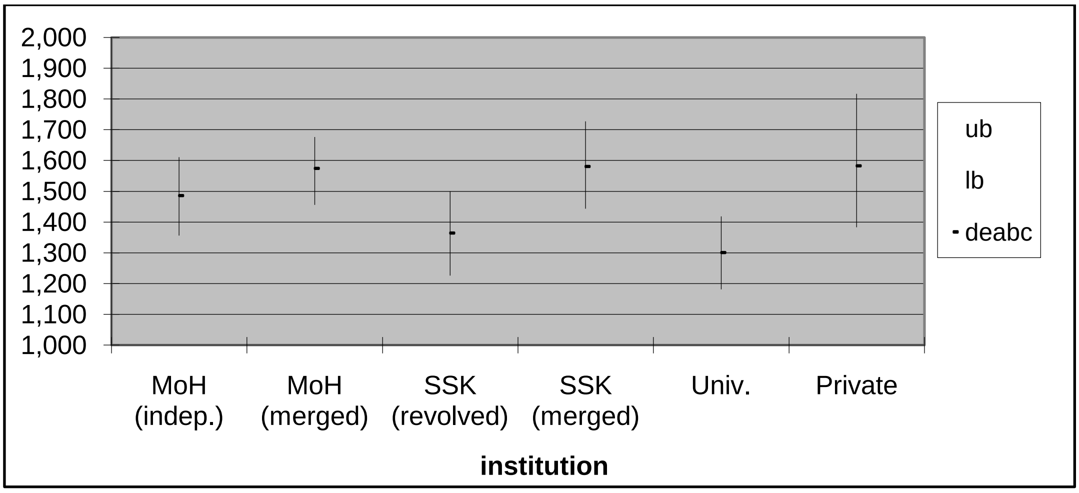
In the year 2003 (i.e. the year just before the reform), as Figure 5.2.1.3 suggests, regardless of ownership type, all hospitals' efficiency scores were worsened and efficiency differentials among different type hospitals deepened and remained significant as in the previous years. Those deepening problems of the Turkish health sector clearly shows the necessity of the reform to establish a general health insurance uniting all the institutions under a single umbrella and to establish a standard association which provides egalitarian, accessible, productive, efficient and high quality health care to its members.

Figure 5.2.1.3. Confidence Intervals for Bias Corrected Efficiency Scores of 2003



Hence, in the light of those problems, in April 2003, a protocol signed between MoH and the Ministry of Finance. With this protocol, civil servants earned right to benefit from private health institutions and their expenditures in private hospitals were financed by their own institution, namely ES. In July 2003, MoH, Ministry of Labor and Social Security and the Ministry of Finance signed a collective utilization protocol that enabled the members of BK, ES, active public employees and green card holders to benefit from SSK hospitals, and that enabled members of SSK to benefit from MoH hospitals. As a result of those attempts that aimed to distribute excess burden on SSK hospitals and to stimulate the demand towards other hospitals operating undercapacity, we observe more promising results in 2004. According to the Figure 5.2.1.4 below, with the introduction of first steps of the reform, a convergence trend in efficiencies of different type of institutions is observed. In other words, significant efficiency differentials among hospitals began to be eliminated, leading towards more uniform health delivery.

Figure 5.2.1.4. . Confidence Intervals for Bias Corrected Efficiency Scores of 2004



Particularly, in the year 2004, we observe an improvement in the efficiency scores of MoH (both merged and independent.), university and private hospitals whereas a deterioration in SSK (both revolved and merged) hospitals, as rationing of patients with respect to the membership is alleviated. That is, on one hand, SSK members began to shift towards MoH, university and private hospitals and on the other hand, due to the invasion of MoH hospitals by SSK members, civil servants have started to use private hospitals. This led to a more equal distribution of burden among hospitals and hence increasing efficiency of MoH, university and private hospitals.

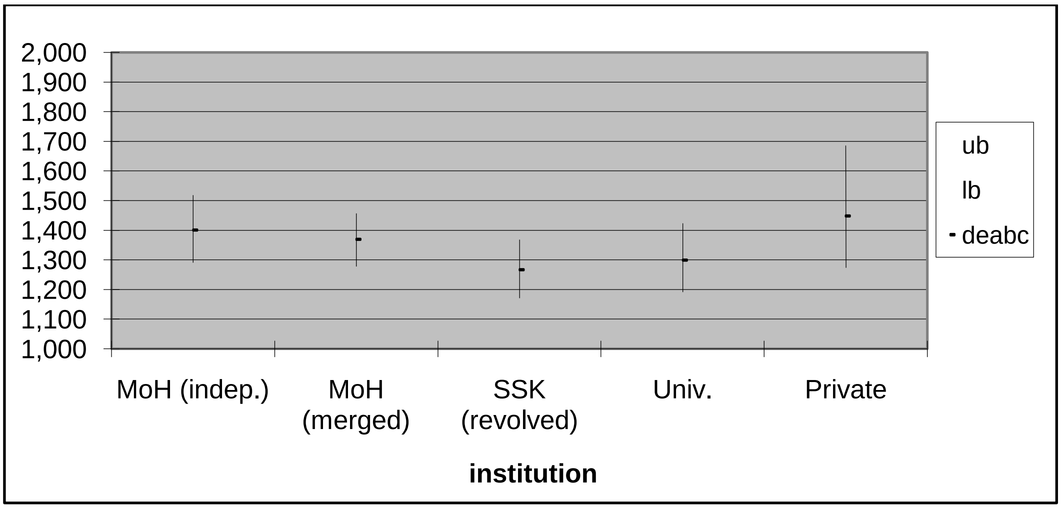
In 2005, universal health coverage was introduced in Turkey. With this final step, ownerships of all SSK hospitals were transferred to the MoH and all security institutions are gathered under one roof, namely *Social Security Institution* (SGK). From 2005 onwards, all patients are covered by SGK and all patients could benefit from either MoH, university or private hospitals.* Surprisingly, the results of 2005 suggest that efficiency scores of all type of institutions, with the exception of private

* Note that we can follow SSK (merged) hospitals until the year 2004 because unlike SSK (revolved) hospitals that were transferred to the ownership of MoH, those ones were abolished thereafter.

ones, declined compared to 2004 scores (see appendix B, Figure 5.2.1.5). The most remarkable deterioration is observed in revolved SSK hospitals (i.e. mean DEA score increased from 1.364 to 1.533), a finding which is consistent with a declining number of outpatients in revolved SSK hospitals by 2 million from 2004 to 2005. A good explanation of this sharp decline could be that beginning from 2004, the shift of SSK members towards MoH hospitals to benefit from less crowded hospitals and to get more qualified health care was accelerated. Hence, this further reduced the efficiency of revolved SSK hospitals by reducing their output level, given the inputs. Moreover, in 2005 a shock was given to the existing health care system and the system experienced an adaptation process. The change which was implemented both administratively and managerially lengthened the adaptation period to the new system and this reduced the overall efficiency in 2005. By contrast, an improvement in efficiency of private hospitals in this period could be attributed to the encouraging efforts of the government to attract private investments to health sector.

However, in 2006, when the unification process has taken its roots, as Figure 5.2.1.6 suggests, the convergence process that began in 2004 became noticeable.

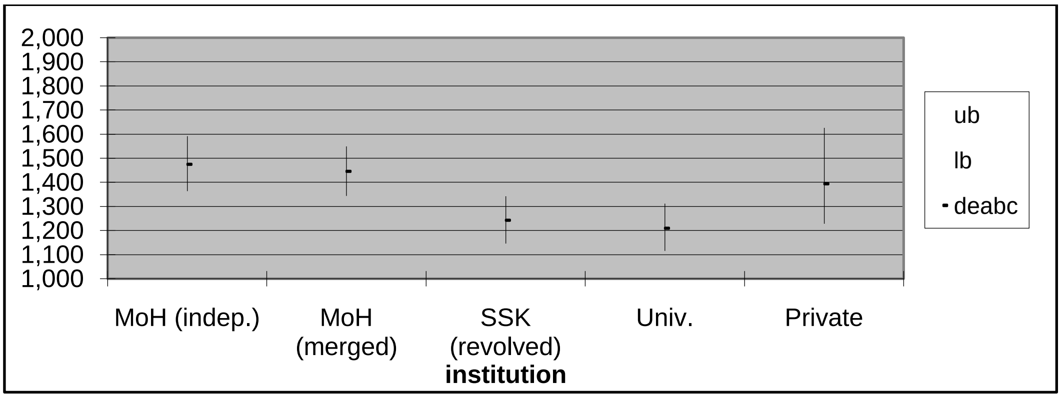
Figure 5.2.1.6 Confidence Intervals for Bias Corrected Efficiency Scores of 2006



Moreover, Figure 5.2.1.6 indicates that there exists an improvement in efficiency scores of all type of institutions, with previously SSK owned revolved hospitals being the most efficient whereas the private hospitals being the least efficient ones. Also, as Table 5.2.1.1 shows, overall efficiency of Turkish health care sector has increased when compared to the pre-reform period (i.e. the period of 2001-2003), a finding which is also supported by Figure 5.2.1.6. Therefore, one may conclude that positive expected effects of the reform began to be realized.

In 2007, we observe further improvements in efficiency scores of SSK, university and private hospitals whereas worsening in MoH hospitals. According to Figure 5.2.1.7, to some extent convergence obtained in 2006 has broken down.

Figure 5.2.1.7. Confidence Intervals for Bias Corrected Efficiency Scores of 2007



By contrast to the bootstrap efficiency scores above, efficiency components of the Malmquist index scores of MoH (merged) and private hospitals indicate an improvement in efficiency of MoH (merged) but deterioration in efficiency of private hospitals in 2007. However, as Table 5.2.2.1 below suggests, this inconsistency actually arises from unexpected scale efficiency changes in the post reform period. Although pure efficiency components of Malmquist index for those hospitals are in line with efficiency changes indicated by bootstrap DEA, efficiency components are not because changes in scale efficiency offset changes in pure efficiency in overall.

5.2.2. Application and Comparison of Malmquist Productivity Index Scores

The output oriented and bootstrapped Malmquist productivity index with its three components, namely technical change, pure efficiency change and scale efficiency change is estimated for all type of hospitals in the sample over the period of 2001-2007. The results are shown in Table 5.2.2.1 below:

Table 5.2.2.1. Cumulative Malmquist Index and Its Components, 2001-2007

OVERALL	MALMQUIST	EFFCH	TECHCH	PUREFFCH	SCALEFFCH
2001	1,000	1,000	1,000	1,000	1,000
2002	1,028	0,987	1,042	0,981	1,005
2003	1,017	0,967	1,052	0,963	1,005
2004	1,097	1,022	1,074	1,016	1,006
2005	1,119	0,951	1,176	0,973	0,978
2006	1,116	1,078	1,035	1,063	1,014
2007	1,216	1,083	1,122	1,043	1,039
MoH (Indep.)					
2001	1,000	1,000	1,000	1,000	1,000
2002	1,019	0,997	1,022	0,988	1,010
2003	0,979	0,953	1,027	0,951	1,002
2004	1,129	1,046	1,079	1,050	0,996
2005	1,169	0,977	1,198	1,009	0,968
2006	1,131	1,101	1,028	1,103	0,998
2007	1,247	1,056	1,182	1,048	1,008
MoH (merged with SSK)					
2001	1,000	1,000	1,000	1,000	1,000
2002	1,018	0,985	1,033	0,993	0,993
2003	1,002	0,965	1,039	0,944	1,022
2004	1,173	1,120	1,048	1,123	0,997
2005	1,154	1,022	1,129	1,116	0,915
2006	1,199	1,230	0,975	1,275	0,964
2007	1,345	1,243	1,082	1,215	1,023
SSK (revolved)					
2001	1,000	1,000	1,000	1,000	1,000
2002	1,062	0,988	1,075	1,002	0,986
2003	1,092	0,949	1,151	0,983	0,965
2004	0,980	0,895	1,095	0,907	0,987
2005	0,935	0,789	1,185	0,815	0,968
2006	1,001	0,942	1,062	0,937	1,006
2007	1,081	1,014	1,065	0,958	1,059

Table 5.2.2.1 (cont'd)

SSK (merged with MoH)	MALMQUIST	EFFCH	TECHCH	PUREFFCH	SCALEFCH
2001	1,000	1,000	1,000	1,000	1,000
2002	1,034	0,968	1,068	0,976	0,991
2003	1,064	0,929	1,146	0,950	0,978
2004	0,951	0,875	1,087	0,874	1,001
University					
2001	1,000	1,000	1,000	1,000	1,000
2002	1,031	0,952	1,084	0,920	1,035
2003	1,074	1,120	0,959	1,018	1,100
2004	1,134	1,132	1,002	1,036	1,092
2005	1,166	1,021	1,141	0,958	1,066
2006	1,203	1,150	1,046	1,018	1,129
2007	1,275	1,349	0,945	1,087	1,240
Private					
2001	1,000	1,000	1,000	1,000	1,000
2002	1,036	0,965	1,074	0,976	0,989
2003	1,098	0,944	1,163	0,961	0,983
2004	1,095	0,991	1,105	0,977	1,014
2005	1,122	1,071	1,047	1,062	1,008
2006	1,173	1,112	1,054	1,057	1,051
2007	1,198	1,098	1,091	1,106	0,991

This table allows us to follow the changes in productivity trends of hospitals over the period of 2001-2007. The values in the table are the geometric means of bootstrapped Malmquist scores of each type of hospital and they are obtained cumulatively over 2001-2007. Hence, as noted earlier, a value greater than unity indicates improvement in that component whereas a value less than unity indicates deterioration.

On this basis, as Table 5.2.2.1 suggests, from 2001 to 2007, we observe significant improvements in Malmquist scores of MoH (indep) hospitals. Up to 2006, this increase in their productivity could largely be attributed to the efficiency change, implying that production gets closer to the best practice frontier, rather than technical change, more particularly, this progress in efficiency stems from the pure efficiency change rather than scale efficiency change. However, in 2007, the trend for MoH (indep) is reversed. In 2007, the enhancement in productivity of MoH (indep) is largely due to the improvements in their technical change, even though all components are above the unity. By contrast to the previous years, in 2007, MoH (indep) hospitals began to experience developments also in their scale efficiency scores implying that they get closer to the optimal scale of production. Moreover, it is important to note that the year 2004 in which the first steps of the reform was introduced represents a kind of turning point for MoH (indep) hospitals because thereafter they began to undertake significant progresses in their Malmquist score and in its components.

The similar trends also apply for the MoH (merged) hospitals. The improvements in their productivity scores arise largely from efficiency and pure efficiency changes, with jumps in their technical and scale efficiency scores in 2007.

For SSK (revolved) hospitals whose ownership are transferred to MoH in 2005, we observe a productivity loss over the period of 2001-2007 (i.e. a decline from 1,062 to 1,001). Except for 2004 and 2005, the improvements in their technical change, and later in scale efficiency change are able to offset the worsening in the efficiency and pure efficiency change, leading to Malmquist scores above unity and hence an improvement in overall productivity. Note that in 2004, the year just before the transfer of SSK (revolved) hospitals to the MoH, we observe a Malmquist score below unity, implying the necessity of the reform. Also, in the first year of the reform, in 2005, we observe deterioration in productivity which is largely due to the uncertainties of the transition period. However, in 2006 and 2007 positive effects of the reform began to be realized, yielding to significant improvements in productivity and its components. Currently, productivity improvements in SSK (revolved) hospitals still rely mostly on technical change rather than efficiency change, implying that they encounter outward shifts in their production frontier.

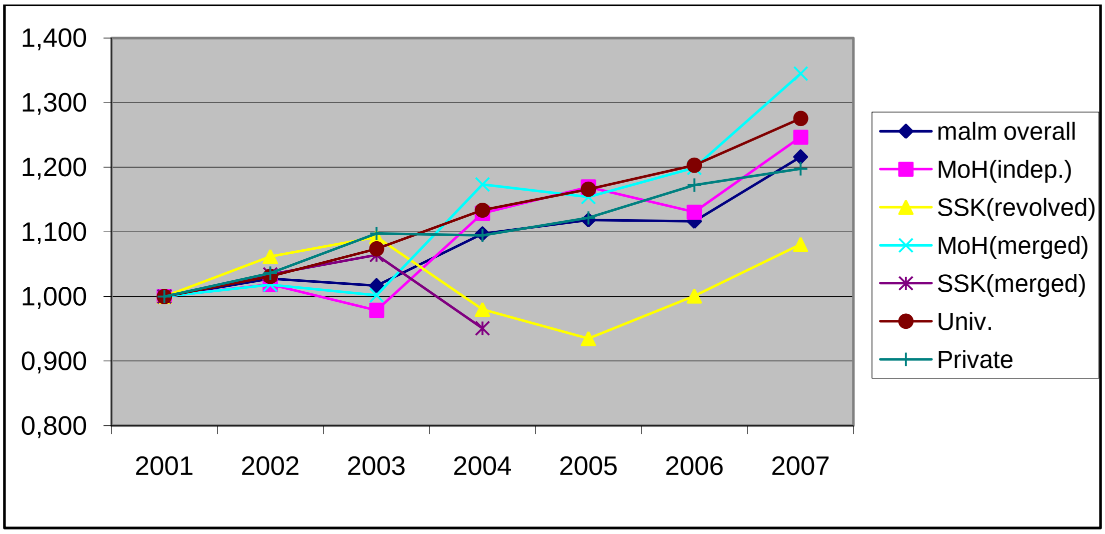
As noted earlier, SSK (merged) hospitals could be followed up to 2004 because unlike SSK (revolved) hospitals, those ones are merged with the MoH (merged) and completely abolished thereafter. Based on the Table 5.2.2.1, the Malmquist scores for SSK (merged) hospitals indicate that similar to SSK (revolved) hospitals, those ones also relied on technical change rather than efficiency change to meet the increased demand for the health services. However, improvements in their technical change component could not offset the deterioration in efficiency change component in 2004, leading to reduction in productivity. Therefore, the results indicate that the mergers between SSK and the corresponding MoH hospitals actually contributed to the productivity of MoH (merged) hospitals and at the the same time it enabled the elimination of those unproductive SSK (merged) hospitals.

For university and private hospitals, we expect a productivity improvement that mainly stems from scale efficiency improvements as members of SSK began to benefit from university and private hospitals from 2004 onwards. The results found are in line with our expectations. According to Table 5.2.2.1, for both university and private hospitals, there exist improvements in overall productivity scores and its components with significant improvements in scale efficiency from 2004 onwards.

In overall, according to Table 5.2.2.1, from 2001 to 2007, Turkish health sector has experienced a noteworthy productivity improvement that is concentrated on the last two years of the reform and that is largely due to the technical changes.

The Figure 5.2.2.1 below summarizes the results of Table 5.2.2.1. The figure shows cumulative Malmquist index scores in Table 5.2.2.1 over the period of 2001-2007. In the figure, the period of 2001-2004 represents the pre-reform period and the period of 2005-2007 represents the transition and the post reform periods.

Figure 5.2.2.1. Cumulative Malmquist Index Scores, 2001-2007

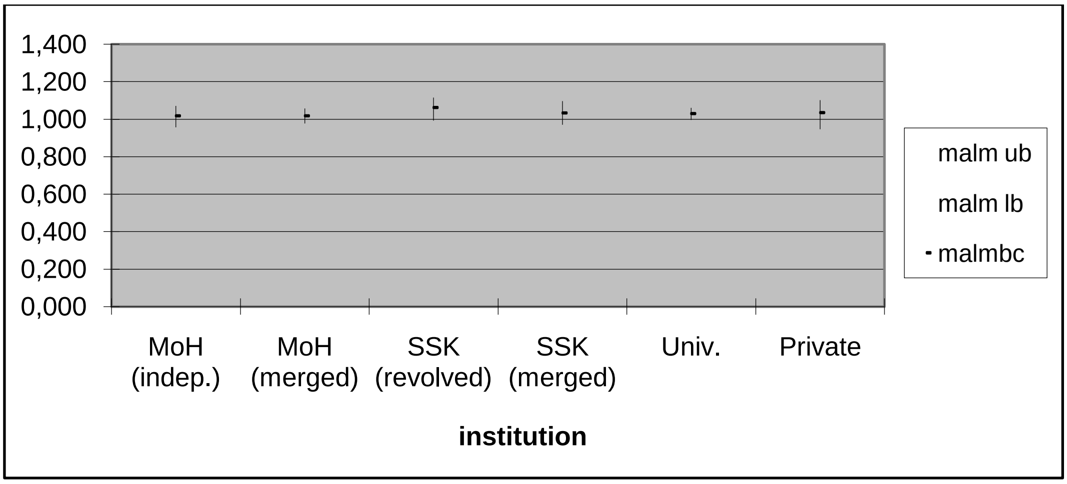


On this basis, as figure 5.2.2.1 also suggests, the year 2004 characterizes a turning point in productivities. From 2004 onwards, MoH (indep), MoH (merged), university and private hospitals experience productivity improvements above the overall average whereas SSK (revolved) hospitals fall behind it. Moreover, poor performance of SSK (merged) hospitals over 2001-2004 period actually supports the idea of the reform (note that SSK (merged) hospitals could be followed only up to the year 2004). Hence, all those results obtained are in line with our prior expectations and are in favor of the reform.

Another important issue that needs to be addressed in this section is that whether the productivity changes as measured by the Malmquist index are significant in a statistical sense. If it is significant, then the results imply a real change in productivity, otherwise it should be considered as nothing more than a trick of sampling noise. To distinguish between the two, the results obtained by bootstrapping which provides the estimates of bias corrected Malmquist index scores within a given confidence interval could be used.

On this basis, Figure 5.2.2.2* shows the confidence intervals for bootstrapped Malmquist indices of 2001-2002 for each institution.

Figure 5.2.2.2. Confidence Interval for Bootstrapped Malmquist Index of 2001-2002

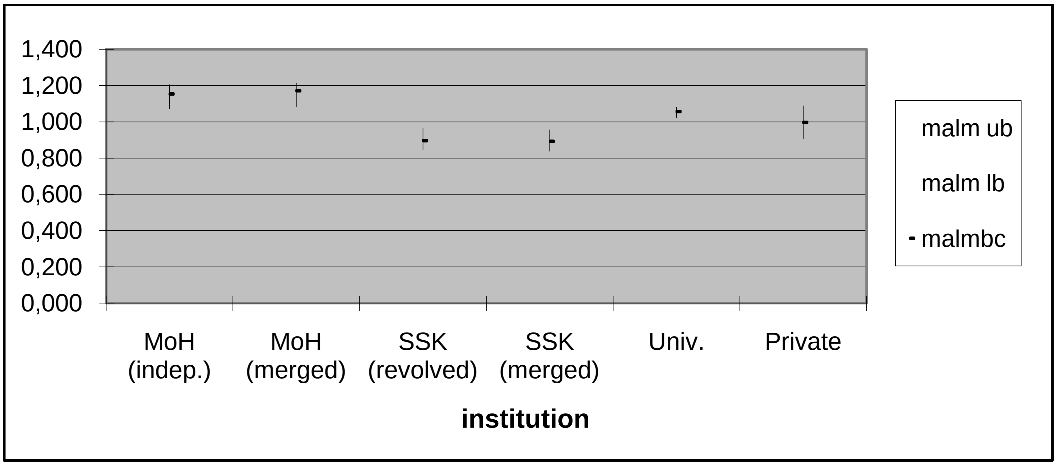


In the figure, when value one is assumed as critical point, it can easily be seen that the estimated Malmquist indices are significantly above one. Hence, one can conclude that all type of institutions experienced significant productivity improvements in a statistical sense from 2001 to 2002, with SSK hospitals, especially the revolved ones being more productive than MoH (both indep and merged) hospitals. Hence, there exist productivity differentials among SSK hospitals and the rest of the hospitals. Moreover, narrow confidence interval widths suggest the accuracy of our estimation.

The following figure shows the confidence interval for each institution and corresponding bootstrapped Malmquist index scores, from 2003 to 2004, i.e. the year just before the reform (for Malmquist scores and confidence intervals of 2002-2003 period, see Appendix B, Figure 5.2.2.3).

* In the following figures, malm ub stands for upper bound of the confidence interval for Malmquist index whereas malm lb stands for lower bound and malmbc denotes the bias corrected Malmquist index score.

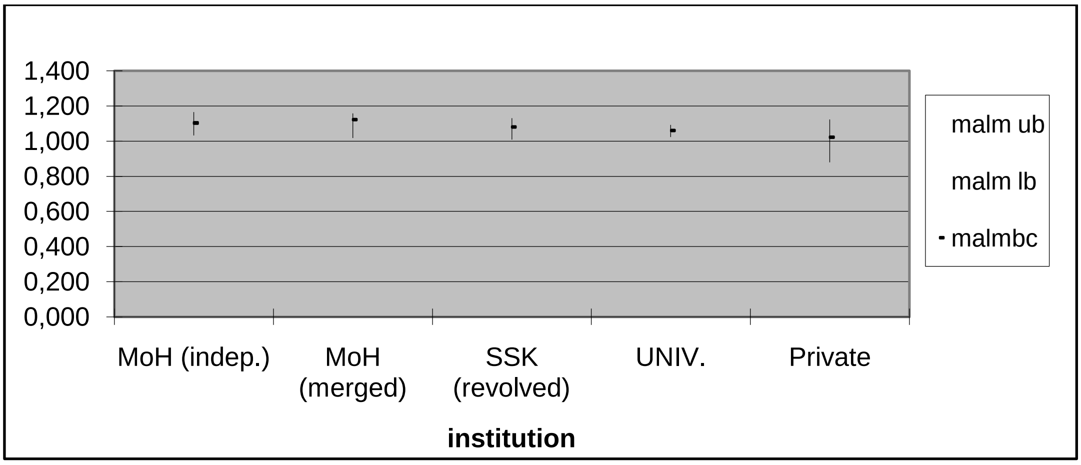
Figure 5.2.2.4. Confidence Interval for Bootstrapped Malmquist Index of 2003-2004



When compared to Malmquist scores of 2001-2002, in this case we have higher productivity scores for MoH (both indep and merged) hospitals and lower productivity scores for SSK (both merged and revolved) hospitals, a finding which is also supported by Figures 5.2.1.4 and 5.2.2.1, as members of SSK began to benefit from MoH hospitals due to the collective utilization protocol signed between MoH, Ministry of Labor and Social Security and the Ministry of Finance in July 2003. With this protocol, as our results also suggests, outputs of MoH hospitals have increased whereas outputs of SSK hospitals have decreased, given the inputs, leading MoH hospitals to be more productive by enabling those hospitals to employ their previously unused capacity. Moreover, we observe a small amount of improvement in productivity scores of university hospitals which may be a result of increased demand of MoH members for affordable and higher quality health care which could not be satisfactorily provided by MoH hospitals since the invasion of SSK members to MoH hospitals due to the new law. By contrast, we observe deterioration in productivity scores of private hospitals from 2003 to 2004. Moreover, we observe significant productivity differentials not only in efficiency scores but also in productivity scores of institutions in this period (see Figure 5.2.1.4.), implying a need for standardized health delivery system that will be introduced in 2005.

The Figure 5.2.2.7 shows the confidence intervals and corresponding bootstrapped Malmquist index scores, in 2006-2007 for each institution. (for Malmquist scores and confidence intervals of the periods 2004-2005 and 2005-2006, see Appendix B, Figure 5.2.2.5 and Figure 5.2.2.6).

Figure 5.2.2.7. Confidence Interval for Bootstrapped Malmquist Index of 2006-2007



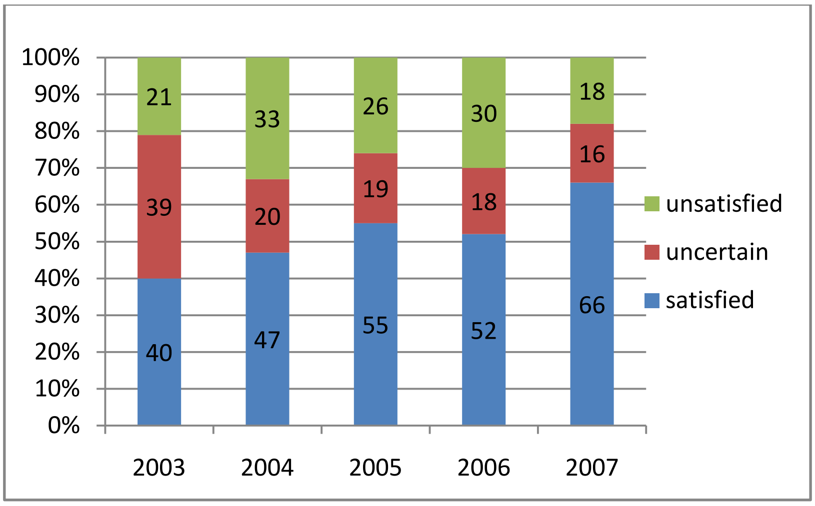
In the figure, we have productivity scores which are significantly above the unity. When compared to the Malmquist index scores of 2001-2002, in this period, all institutions experienced significant productivity improvements, except with a small productivity loss in private hospitals which may be due to the government's attitude to coordinate monetary and fiscal policies together with movements in private investment. When compared to the Malmquist index scores of 2003-2004, we observe significant improvements in productivity scores of SSK (revolved), university and private hospitals but a small decline in productivities of MoH hospitals, due to the unification of health services.

Besides those, in this period, similar to the trend in efficiency scores, we can observe a convergence also in productivity scores of institutions (see Figure 5.2.1.6.). In other words, significant productivity differentials among institutions has eliminated as a result of unification and standardization of health services with health sector reform introduced in 2004.

5.2.3. Evaluation of the Reform

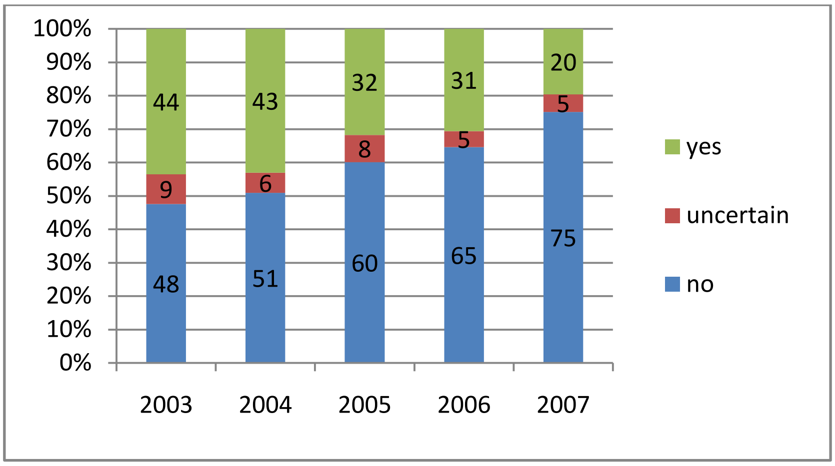
To evaluate the impacts of the reform on society and consistency of our empirical results, it would be beneficial to discuss some concepts such as patient satisfaction, quality of health care services provided and per capita public health expenditures. On this basis, Figure 5.2.3.1 below shows the results of a survey conducted by Turkish Statistical Institute on satisfaction derived from health care services received over the period of 2003-2007.

Figure 5.2.3.1: Satisfaction from Health Care Services, 2003-2007



According to the figure, it seems that, although there are uncertain patients, satisfaction has increased continuously from 2003 (when the first step of the reform was introduced) to 2007, except with a small decline from 2005 to 2006 which corresponds to the transition period. So, one may conclude that the reform managed to increase the percentage of satisfied patients from %40 to %66 within five years. Moreover, within the context of the survey, people are asked whether there exist a problem about quality of health services provided. The results are shown in the following figure:

Figure 5.2.3.2. "Is there a problem about quality of health services?", 2003-2007

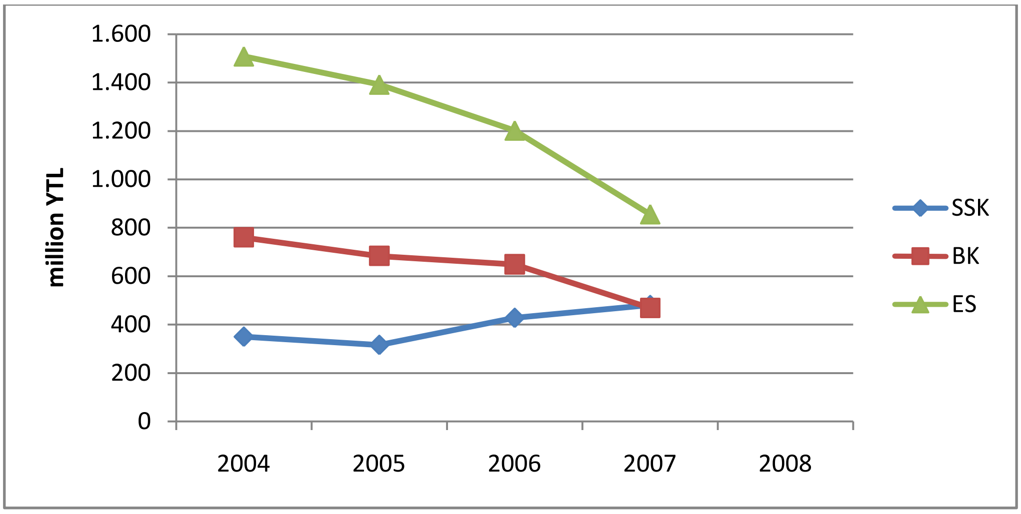


The results clearly show that from 2003 to 2007, percentage of people who found health care service received is of good quality has increased from % 48 to %75. Therefore, from those figures, one can infer that health care reform has actually succeeded in Turkey and positive effects of the reform began to be realized 2005 onwards, particularly.

For the corresponding post-reform period our empirical results suggest that Turkish health sector experienced continuous and significant efficiency and productivity improvements that largely stems from efficiency and scale improvements for MoH, university and private hospitals and from technical improvements for SSK hospitals. Intuitively, this result implies that insufficiencies in health care, inflexibilities in hospital management and inefficiencies in the referral system that caused accumulations in hospitals and increased the costs while decreasing the quality of health service were removed as rationing of patients with respect to membership is alleviated with the implementation of the reform. Hence, as a result of the distribution of excess burden among hospitals, patients are now provided standardized health care services by enough number of health personnel in less crowded, efficiently managed hospitals, regardless of their employment status or type of health coverage and this fact is eventually reflected in patient satisfaction surveys.Therefore, one can conclude that results obtained by Turkish Statistical Institute's survey are in line with our findings.

The following figure shows the real per capita public health expenditures throughout the post reform period.

Figure 5.2.3.3 Real Public Health Care Expenditures (Per Capita), 2004-2008



The figure suggests that real per capita public health expenditures of different institutions follow the same trend as in efficiency and productivity scores and so they converge as reform process has taken its roots. Hence, differences among expenditures has eliminated gradually each year and eventually completely removed in 2008 with the implementation of Universal Health Insurance system which covers the whole population regardless of the employment status. Meanwhile, for the same period, our empirical results (which indicates significant efficiency improvements in efficiency scores of all institutions) imply that from the year 2003 onwards, with the same amount of inputs, institutions have began to produce more outputs and this eventually led to a reduction in per capita health care expenditures as confirmed by the figure above.

To sum up, it seems that the reform process that has been initiated in 2003, has restructured the health care delivery of Turkey, to some extent it has established financially sustainable health care system that covers the whole population and it has improved the quality in health care services delivered by giving patients a possibility to choose the institution they want to be treated and so by encouraging competition among different health care providers.

CHAPTER 6

CONCLUSION

This study investigates the impacts of health sector reform on the efficiencies and productivities of public and private hospitals in Turkey both in the pre and post reform periods, namely the period of 2001-2007, by using DEA, bootstrap DEA, and bootstrap Malmquist productivity index. The sample studied includes 441 hospitals (281 MoH, 85 SSK, 45 university and 30 private) in the pre-reform period and 415 hospitals (338 MoH, 47 university and 30 private) in the post-reform period due to the mergers and transformations.

Bootstrap DEA results indicate that throughout 2001-2003, efficiency scores of all institutions deteriorated and efficiency differentials among institutions widened such that SSK (revolved) hospitals being the most efficient and MoH (merged) hospitals being the least efficient. In 2003, due to the implementation of first steps of the reform, we observed improvements in efficiency scores of MoH, university and private hospitals but deterioration in efficiency scores of SSK hospitals, as rationing of patients with respect to membership is alleviated. In 2006, the year following the unification of all social security institutions under one roof, efficiency scores of all institutions has improved. In 2007, further improvements in efficiency scores of SSK (revolved), university and private hospitals are accompanied with small reductions in efficiency scores of MoH hospitals and efficiency scores of all institutions converge towards each other.

Comparison of bootstrap Malmquist productivity indices indicates that throughout the pre-reform period there were significant productivity differentials among institutions in such a way that SSK hospitals were the most productive whereas MoH hospitals were the least productive ones. Moreover, it seems that in this period almost all institutions suffered from efficiency losses as it is also suggested by bootstrap DEA scores. However, in the post-reform period, all institutions have experienced statistically significant productivity improvements. More particularly, improvements in productivity of SSK hospitals largely relied on technical change whereas those of MoH mostly relied on efficiency change. On the other hand, improvements in productivity scores of university and SSK hospitals could largely be attributed to scale efficiency improvements as SSK members and public employees began to benefit actively from those hospitals. Furthermore, productivity scores of institutions began to converge due to the standardization brought by the reform.

Therefore, it seems that all the expected positive effects of the reform have been realized. Slightly reduced efficiency in previously SSK owned hospitals have been more than offset by increased efficiency in MoH hospitals as well as in private and university hospitals, leading to more accessible, egalitarian and higher quality service provision which also reflects itself in patients' satisfaction surveys and which is due to the less waiting time by switching from queuing regime to an appointment regime. Also, significant scale adjustments in small scale private and university hospitals and significant productivity improvements which are highly instrumental in meeting the health needs of increased patients with health insurance coverage seem to have taken place. Finally, with the standardization of health care provision system among institutions, not only efficiency and productivity scores, but also health care expenditures of institutions converged towards each other, yielding to a uniform health care delivery system. And although it is too early to conclude, one can claim that the reform is able to discipline public health care expenditures and it established financially sustainable health insurance system based on capitation, not on employment status.

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APPENDICES

APPENDIX A

Figure 5.1.1. Changes in the Number of Outpatients Treated Per Year in MoH Hospitals, 2001-2006

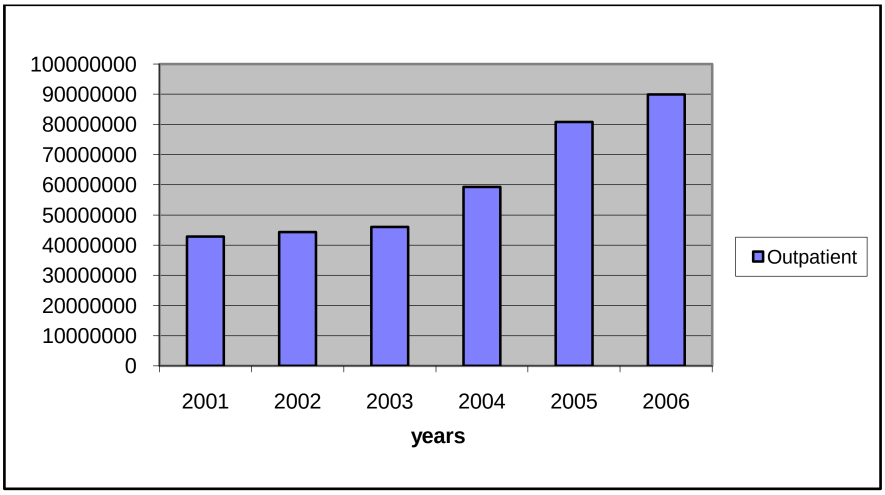
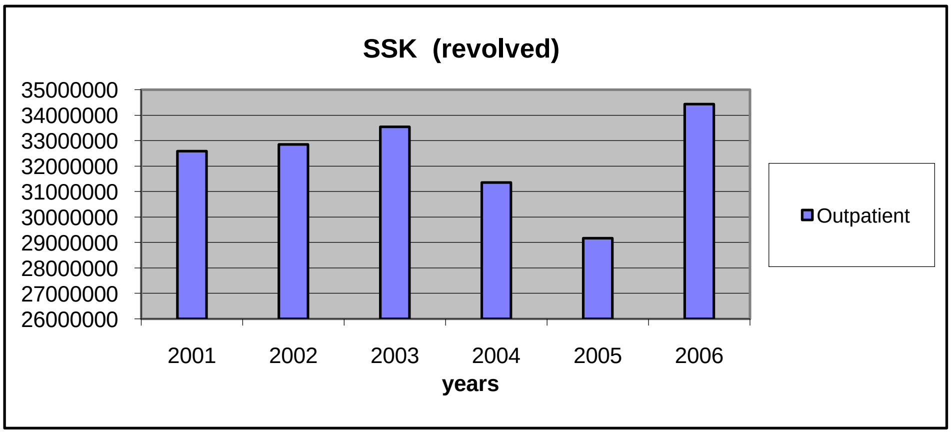
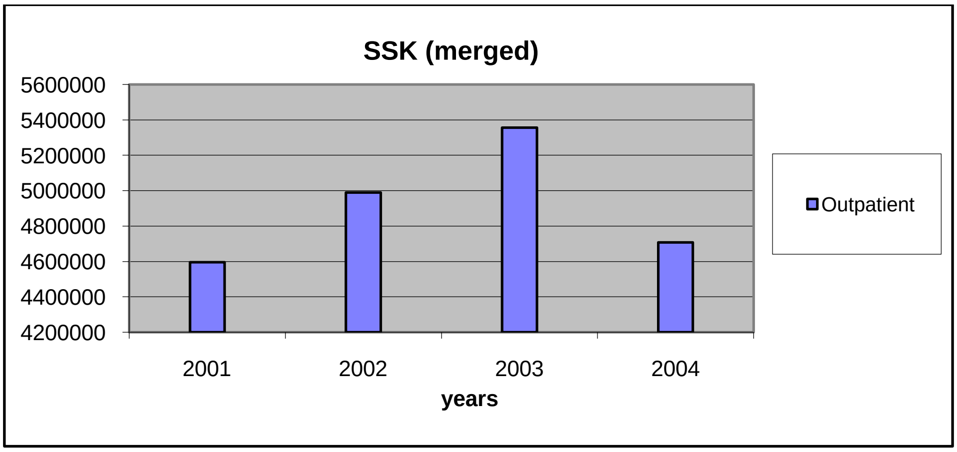


Figure 5.1.2. Changes in the Number of Outpatients Treated Per Year in SSK (revolved) and SSK (merged) Hospitals, 2001-2006





APPENDIX B

Figure 5.2.1.2. Confidence Intervals for Bias Corrected Efficiency Scores of 2002

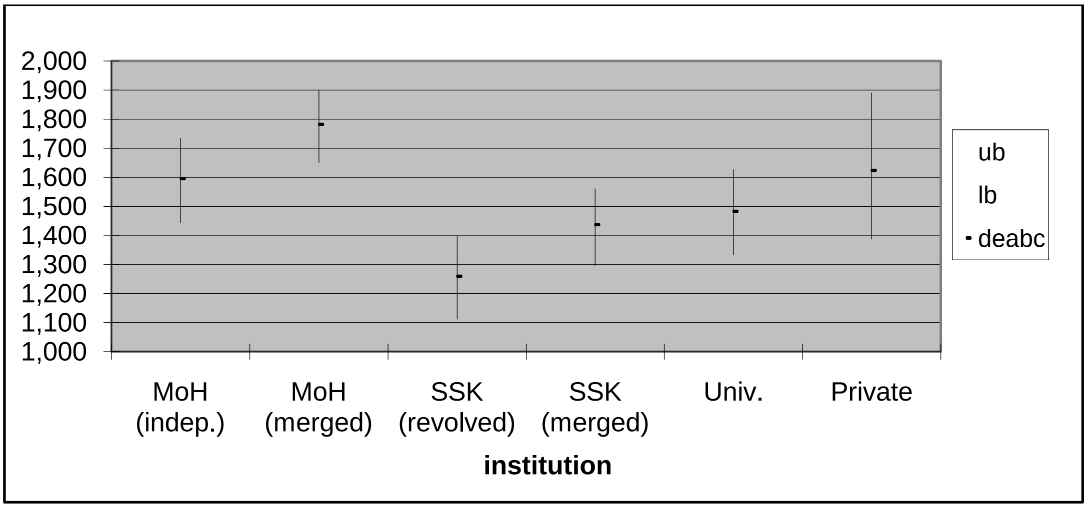
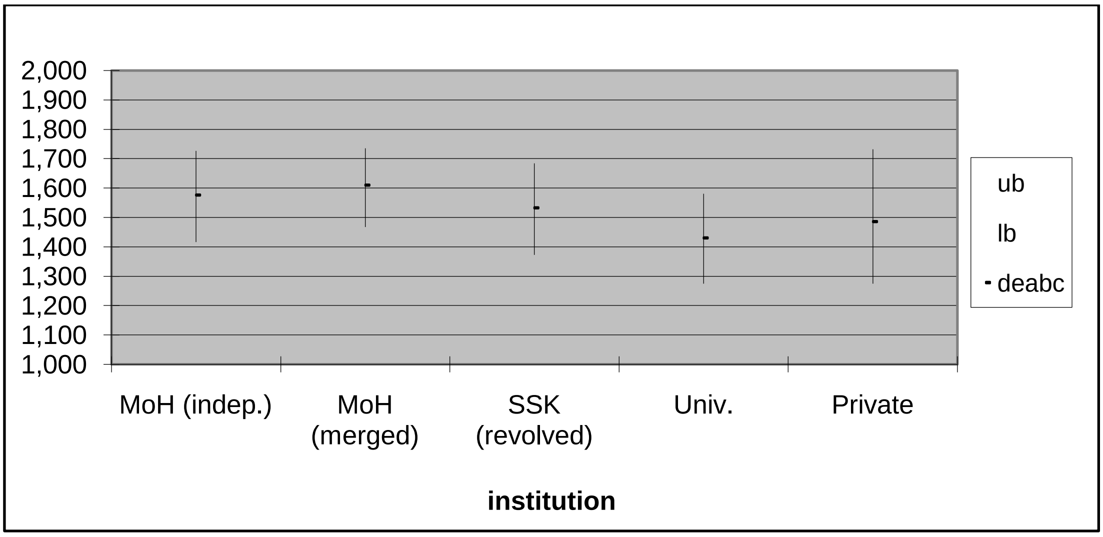


Figure 5.2.1.5. Confidence Intervals for Bias Corrected Efficiency Scores of 2005



APPENDIX C

Figure 5.2.2.3. Confidence Interval for Bootstrapped Malmquist Index of 2002-2003

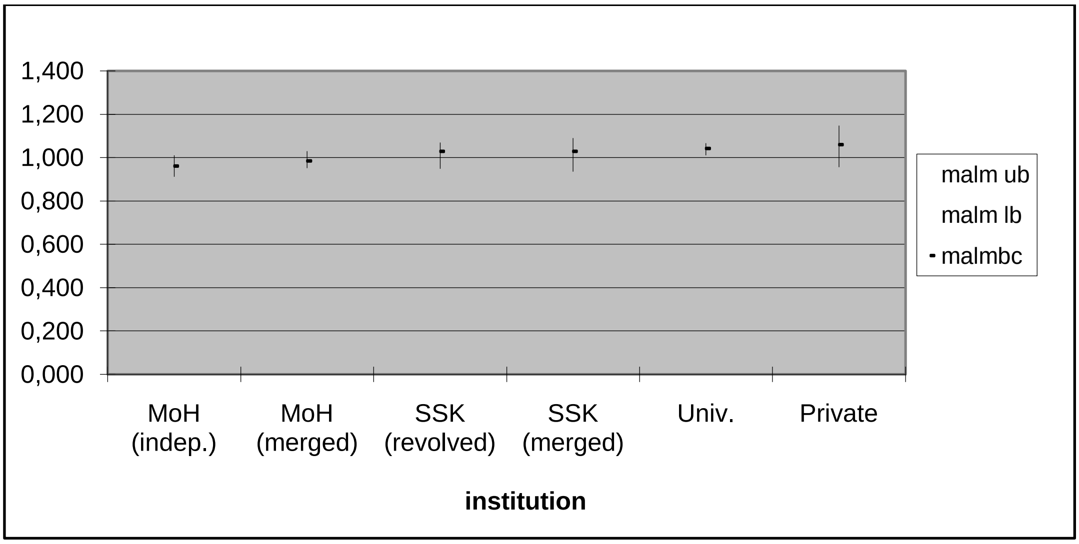


Figure 5.2.2.5. Confidence Interval for Bootstrapped Malmquist Index of 2004-2005

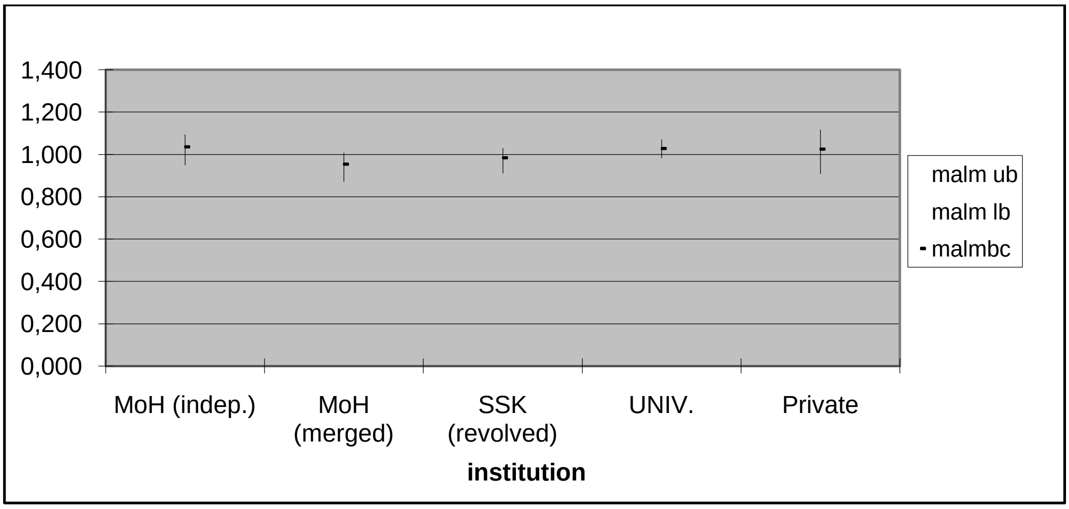


Figure 5.2.2.6. Confidence Interval for Bootstrapped Malmquist Index of 2005-2006