ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF BUSINESS AND ECONOMICS

TECHNICAL EFFICIENCY OF SELECTED HOPITALS IN ADDIS ABABA: DATA ENVELOPMENT ANALYSIS APPROACH

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LIST OF ACRONYMS

Acronym	Description
COLS	**Corrected Ordinary Least Square**
CRS	**Constant returns to scale**
DEA	**Data Envelopment Analysis**
ESHE	**Essential Services for Health in Ethiopia**
FTE	**Full time equivalent**
HCFS	**Health Care Financing Secretariat**
HSDP	**Health Sector Development Program**
WHO	**World Health Organization**
MoH	**Ministry of Health**
SFA	**Stochastic Frontier Analysis/Approach**
SNNPR	**South Nations Nationalities and Peoples Region**
TGE	**Transitional Government of Ethiopia**
TFP	**Total Factor Productivity**
VRS	**Variable returns to scale**
WB	**World Bank**
WHO-CO	**World Health Organization Country Office**

ABSTRACT

The study measured the technical efficiency of seventeen hospitals in Addis Ababa using a five year panel data(2000/01-2004/05) employing both parametric and non-parametric models. We used DEA and DEA-Malmquist models (non-parametric approach) to identify the level of efficiency of hospitals, while determinants of technical efficiency were examined using a censored-Tobit regression model (parametric approach).

Results of the CRS DEA model showed that 5(29.4%) hospitals were found technically efficient, while 12(70.6%) were inefficient. The VRS DEA model indicated 9(52.9%) hospitals were technically efficient and 8(47.1%) hosppitals were technically inefficient. Out of the sampled hospitals, 5(29.4%) hospitals were found scale efficient, while12 (70.6%) were scale inefficient.

The results of the censored-Tobit model indicated that age, size, teaching status, average bed occupancy rate and number of medical doctors to total staff were found significantly associated with technical efficiency scores.

I INTRODUCTION

1.1BACKGROUND

According to Ranis et al (2000), higher levels of human development affect the economy by enhancing people's capabilities and their creativity and productivity. Empirical evidences suggest that people contribute more to economic growth when they are healthier, better nourished and educated. Health is among the main determinants of the composition and growth of output and exports.

Health systems in all countries play a more important role in people's lives than ever before. A kind of health system has existed for long as people have tried to protect their health and treat diseases. Traditional practices integrated with spiritual counseling have existed for thousands of years and still co-exist today with modern care to provide both preventive and curative care. Organized health systems in the modern sense did not exist before ten decades ago. During that period, only few people had an opportunity to visit hospitals while the majority is still threatened by fatal diseases like measles, small pox, malaria etc in poor countries. Infant, child and maternal mortality rates were very high (WHO, 2000).

Health systems have undergone immense reforms in the past ten decades. The founding of national health care systems and the extension of social insurance schemes are among the reforms. Hospitals are staffed by well trained mid wives, nurses, doctors and technicians. This coupled with high technology-equipment, drugs and medicines, lead hospitals to enhance and improve their service delivery by far. Owing to these reasons, hospitals are now

responding to people's demand for better health care than in the past decades in developed and many developing countries (ibid, 2000).

Although well-staffed and organized hospitals provide better services, those, which are poorly structured, badly led, inefficiently organized and inadequately funded, can do more harm than good. In other words, if hospitals are not well staffed and organized and if they lack essential drugs and equipments, they exacerbate ill health of the people than curing them. Patients would also prefer to stay home than visiting such kind of hospital.

With regard to ownership, property rights theory predicts that private profit firms have more of an incentive to maximize profits and minimize costs while the non-profit ones are interested in maximizing prestige thereby the former will be more efficient than the latter (Magnussen J.and Mobley L, 1998; Campbell, 2001).On the other hand, since 1980 most peer reviewed journal articles showed that the performance of non-profit health providers were superior to for-profit health providers (Rosenaw P. and Linder S.H., 2003).Furthermore, they argued that even if economic theory favors the profit health providers and the tax code favors the non-profit providers the distinction between for profit and non-profit no longer apply.

Barnum and Kutzin (1993) have indicated that in less developed countries hospitals consume 50-80 percent of the public sector health resources. Despite the high share of the budget spending on hospital care, hospitals in most countries are inefficient. One of the reasons is that health care administrators do not give much attention to efficiency of hospitals. Policy makers, donors and heath system researchers focus more on heath sector reform -

mobilization of additional resources for health care through user fees and other modalities than focusing to improve efficiencies of hospitals (Eyob, 2000).

Ethiopia's population of 73 million is served by a total of 8,182 health facilities of which 131 are hospitals, 600 health centers, 1,662 health stations, 4,211 health posts and 1,578 are private clinics. In addition to these, 276 pharmacies, 381 drug shops and 1,787 rural drug vendors are available. All these health facilities are served by 2,453 physicians/doctors, 776 health officers, 191 pharmacists, 18,809 nurses along with other technicians and support staff (MoH, 2005).

When we turn to the health status of the country, both the usage of health facilities and the health outcomes are much lower than in most other low-income countries. The life expectancy at birth is 48 while the average less developed countries are 65. Infant and child mortality rates per 1000 live births are 96.8 and 84.5 respectively. Only 29% of the population has access to excreta disposal facilities and only 35.9% has an access to safe and adequate water. One Medical doctor is serving 29,777 people even though WHO recommends one Medical doctor to serve only 10,000 people (MoH, 2005).

Since the state sector strongly dominates on health provision, it is not surprising that if more than 60% of the visits are to government facilities (Collier et al, 2000). The public sector is providing all levels of health care service in all regions of the country. It is not untrue that if it is said that health care service, especially in the rural areas, in general is a state function. However, following the 1991 new economic reform program the participation of the private investors in the health sector is dramatically increasing.

Despite the increasing total expenditure on the health sector, it is still the lowest compared with other low income countries. In the year 2000, the average per capita health expenditure from all sources was only USD 5.6.However, the average per capita health expenditure of Sub Saharan Africa was USD 13 and the average per capita health expenditure recommended by WHO is USD 34(WHO-CO, 2005).

Generally, the people of Ethiopia experience lower levels of health status than other low-income countries. The high number of population is unmatched with the existing health facilities. Even though the participation of private investors in the health sector is increasing, the usage of health facilities is still the lowest. Hence, there is a need to examine the services of the health facilities in order to improve health services in the country. Since efficiency is commonly used to judge health systems, it is very important to study and understand how efficiently the health systems, particularly hospitals function and how their (in) efficiencies can be improved.

1.2 STATEMENT OF THE PROBLEM

An intervention is technically efficient if the maximum improvement in health outcome is achieved using the available input resources. However, if the same or greater outcome is achieved with less of one type of input it shows as the intervention is technically inefficient.

Countries in general and hospitals in particular differ in how efficiently they produce health outcomes using the available input resources. In many Sub-Saharan African countries hospitals particularly second and third level referral facilities consume larger proportion of the total public health budget (Hanson et al, 2002).

In Ethiopia, the government focuses on increasing the physical coverage of facilities to improve the service deliveries. Health facilities such as health posts, health stations and health centers have been expanding vastly in the last ten years particularly in the rural areas and in those regions that are considered relatively underdeveloped.

However, due to the high costs of building facilities and the fixed recurrent expenditure, staffs and supply of material inputs have been reduced per facility. All these lead to reduce the quality of service provision and then lower visits to health facilities by patients. Besides these, in public health facilities resources are poorly used, equipments are poorly maintained and staffs are poorly motivated due to the existing lower salary schemes (Collier et al, 2002).

In the public hospitals, medical doctors often spend time in other health facilities to get additional income. Researchers have argued that since health workers and managers have no incentive to promote allocative or technical efficiency, the public sector is wasteful while due to the driving force of profit maximization in the private sector the shareholders have a strong interest in efficient use of resources. However, studies came up with different results regarding ownership and efficency of hospitals.

Beside the on going debate, it is very important to look at an empirical assessment whether the existing hospitals are efficient or not in order to allocate the scarce health care resources efficiently. It is easy to agree with Hanson et al (2002) that "…***failure to address the problems of hospitals and failure to invest in their solution are perilous omissions".***

More over, Data Envelopment Analysis (DEA) has been extensively used in both developed and developing countries to evaluate the efficiency of health facilities particularly health centers and hospitals. Although Getachew (2002) measured efficiency of public hospitals employing Stochastic Frontier Analysis, no study in Ethiopia has been conducted using DEA to estimate technical efficiency of hospitals. Thus, there is need for such a study to bridge this knowledge gap. In addition to this, since the study will identify the magnitude of (in) efficiencies of hospitals, it provide guidance to those researchers and policy makers in their effort of conducting research and designing appropriate policy in health care efficiency.

1.3 OBJECTIVES OF THE STUDY

In light of the stated problem, this study has the general objective of measuring the technical efficiency of a sample of selected hospitals in Addis Ababa. Its specific objectives are:

- To estimate the technical and scale efficiency of selected hospitals in Addis Ababa,
- To identify factors that are likely to affect the (in) efficiency of hospitals and finally on the basis of empirical evidence to suggest policy implications for health sector policy makers.

1.4 SIGNIFICANCE OF THE STUDY

Understanding the (in) efficiencies of hospitals and identifying the sources of (in) efficiencies are important policy concerns for the country's health system. This assessment

will be useful for policy makers to design appropriate policy and managerial interventions for efficient use of limited health care resources thereby to ensure that the population benefits from the resulting efficiency gains. Moreover, the study will motivate researchers to conduct further studies in the area covering all hospitals in the country and also help them to replicate the methodology in other sectors of the economy.

1.5 SCOPE AND LIMITATIONS

The results of this study could be limited by a number of factors. First, the available data indicated that the total numbers of hospitals are 131. However, only hospitals that are providing service in Addis Ababa were considered due to the availability and accessibility of data and for the purpose of panel data estimation only hospitals with more than five years of operation were selected.

Second, due to the difficulties of measuring the outcome of health services-improvement in health or the relief of suffering-like most researchers, we measured intermediate outputs of health services and due to lack of the available data, the study did not include quality of services in the measurement analysis.

Finally, hospitals are recording fees and costs of services on aggregate basis than on each service, thus this analysis was limited to only measuring technical efficiency of hospitals excluding allocative efficiency due to the difficulties of obtaining price data for some of the variables.

1.6 ORGANIZATION OF THE STUDY

The remaining part of the study is organized as follows. Chapter two reviews health sector of Ethiopia and chapter three is devoted to review both theoretical and empirical literatures on technical efficiency of hospitals. In Chapter four the methodological approach employed in the study are discussed. The data analysis and empirical findings are discussed in Chapter five. Summary and conclusions are given in Chapter six.

II REVIEW OF HEALTH SECTOR OF ETHIOPIA

2.1 HEALTH STATUS DEVELOPMENT IN ETHIOPIA

Ethiopia has a land area of 1.1 million square kilometers and has a federal government structure with nine regional states and two city administrations. The administrations are sub-divided in to 580 administrative weredas (districts) and the weredas are sub-divided in to 15,000 kebeles that are organized under urban dwellers associations in towns and peasant associations in rural areas.

The country has a total population of 73 million of which 85% live in rural areas depending on subsistence agriculture. The total fertility is 5.9 children per woman and the life expectancy at birth is 48.Its annual per capita income is US $ 110 and 47% of the population lives below the poverty line (MOH, 2005).

Before the emergency of modern medical practices, the country has its own traditional methods based on majico-religious beliefs to combat diseases and injuries. The population used to visit "Wegesha" for treating a dislocated joint, drink "kosso" for treating tape worm and other abdominal diseases and for diseases which has psychiatric nature they used "tebel"(Holy water).The first western medical practices emerged in the 16th century in the period of Lebne Dengel (1520-1526) and from time to time physicians from different countries used to come and serve.

The first hospital in the country was established in 1896 by the Russian Red Cross mission and formalized health services was laid in 1908 by opening an office for health work in the ministry of interior. In 1909, the first government hospital that is Minilik II was established and the first health personnel training school was the Red Cross nursing school.

In the Imperial period, the first two five years development plans(1958-1962 and 1963-1967) emphasized on development of national health consciousness, co-coordinated approach to public health, preventive medicine, decentralization of public health institutions and extension of hospital facilities. The issue of efficiency addressed in the third year development plan (1968-1973).In this plan, it was stated to take main effort and steps to improve efficiency of the existing hospitals and staffs. It was aimed to treat maximum number of patients with the existing facilities by increasing the nursing to patients ratio and the supply of drugs and equipments. At the end of the imperial period, there were 85 hospitals, 93 health centers and 650 health stations (MoH, 1978).

In 1974, the Derg regime re-organized the health delivery based on the socialist ideology to give a decentralized efficient and economical health service system. The health service was delivered in five tiers: at kebele level, at the wereda (district) level, at awraja (provincial) level, at regional level and at central level. In the ten year leading plan (1985-1994), full community participation in the area of support, monitoring and evaluation was emphasized to improve the effectiveness and efficiency of health facilities. However, due to civil war, the health facilities were neglected and under funded. In 1988, there were 88 hospitals, 156 heath centers and 2,193 heath stations. The facilities increased by 3.5%, 67.7 % and 237.4 %

respectively when they are compared with at the end of the imperial period (PMGSE, 1985; MoH, 1987).

The health policy of the 1991 Transitional Government focuses on decentralization of the health service system, development of the preventive and promotive component of the health care and equitable and acceptable standard of health service system and assuring accessibility of health care for all segments of the population. In the 1998 health care and financing reform strategy, the issue of increasing efficiency in the use of available resources was explicitly stated.

Moreover, the government has launched health policies and strategies that enable private investors, non-governmental organizations and communities to participate in the health sector. As a result, health facilities have been increasing significantly relative to the previous two regimes. Among the new health facilities, 19 private hospitals are emerged, of which 17 in Addis Ababa, 1 in Dire Dawa and 1 in Tigray region. In this period, hospitals and health centers have increased by 48.9%, 284.6% respectively while health stations decreased by 24.2% compared with at the late period of the Derg (TGE, 1993(a); TGE, 1993(b); MoH, 2005).

Generally, in the development plans of the three regimes the issue of delivering efficient health services was addressed. However, due to the low number of health facilities and coverage, the governments were concerned on expanding the physical coverage of health facilities than delivering the services efficiently.

2.2 HEALTH STATUS, COVERAGE AND UTILIZATION

The population of Ethiopia experiences poor health status relative to other low-income countries. Limited access to basic services such as water and sanitation, inadequate access to health services and lack of adequate nutrition are the main causes of the poor health status of the country. The country's 60-80 percent of the health problems is caused by infectious and communicable diseases. Since 54 percent of the rural population use rivers/lakes for drinking, cooking and sanitation purposes they are vulnerable to water borne disease. Due to lack of managing food self sufficiency and food security as well as lack of knowledge about nutritional requirements and poor dietary habits, malnutrition is widespread in the country. In 2004, 8.3 percent of the children are wasting while 46.9 percent and 37.1 percent are stunting and underweight respectively (Befekadu and Birhanu, 2000; MoH, 2005).

To improve the health status of the country, the new government has launched a twenty year health sector development program through five year rolling plans. The first health sector development program (HSDP I) covered the period 1997/98 to 2001/02, the second from 2002/03 to 2004/05 and the third covers the period 2005/06 to 2009/10.In the new health policy, the government employs decentralization of power to the wereda level. The ministry of health and regional health bureaus are responsible only on policy matters and technical supports while the weredas are responsible on managing and coordinating the operation of

the primary health care services. Apart from this, the government focuses on equitable, preventive and acceptable standard of health.

During the period 1999, access to safe water and sanitation in the country was 24 and 15 percent respectively while the rate was 24 and 15, 49 and 86 and 46 and 13 in Kenya, Eritrea and Sudan respectively. Although this rate has improved recently, access to services are still limited. During the 2004/05 period, only 35.9% and 29% of the population had access to safe water and to excreta disposal facilities. The rates vary highly among regions and between rural and urban category. For instance, only 25.2% of the rural population had access to safe water while the share of the urban was 92.4%. Regarding the regions, Addis Ababa (99%), Dire Dawa(90.8%) and Harari(73.3%) are better in terms of access to safe water, while Benshangul-Gumuz(27.2%),Amhara(28%) and Oromia(32%)are the poorest (MoH,2001;MoH,2005).

Child and maternal mortality rate are among the highest in the world. The overall under five mortality rate is 123 per 1000 while maternal mortality rate is 871 per 100,000 live births. However, the rates decreased by 50.2% and 56.5% respectively compared with two decades ago. Poor nutritional status, infections, high fertility rate and low levels of access to reproductive health and obstetrics are still among the main causes of maternal mortality (WHO-Co, 2005).

The HIV/AIDS prevalence rate is also the highest in the world. In 2004/05 the rate is 4.6% but it has decreased significantly when it is compared with 10.63% of 1999. The potential health service coverage and utilization is 72.1% and 0.3% respectively. It is highly increased

when it is compared with the 2000/01 rate of 59.1% and 0.27%. These show as the rates have been improving in recent years. Distance, quality of care and cost are the main reasons for deciding whether or not to seek health care and where to go to seek it. The life expectancy of the population is 48 years which is equal to the sub-Saharan African standard. However, when it is compared with the 2001/02 of 54 it is decreased by 12.5 %(WB, 2004).

Generally, the rate of access to safe water, sanitation and health services as well as health service utilization are among the lowest in the world while child and maternal mortality rate and the HIV/AIDS prevalence rate are the highest in the world. However, although the improvement is gradual the rates have been improved due to the vigorous participation of government, non-governmental organizations and the private sector in the health sector.

Therefore, apart from implementing its strategies, since the resources are scarce the government should emphasize on the area of efficient use of resources to improve the overall health status of the population.

2.3 HEALTH FACILITIES, FINANCING AND INVESTEMENT

Before the 1991 new economic reform, the health care infrastructure of the country had been crippled by civil war, under funding and neglect. The number of health facilities and their distributions and quality were sub-standard. The emphasis was given to curative and hospital based care than a preventive and community based health care system (Befekadu and Birhanu, 2000).

Following the new economic reform program, the participation of private investors in the health sector has increased significantly. However, although health facilities have been increasing recently it is still limited and the supply is also unevenly distributed among regions. Most of the health facilities and health professionals are concentrated in the urban areas particularly in Addis Ababa.

According to the new health strategy, health services are provided under four-tier system. These are primary care health units that provide primary health care services and some surgical treatment, district hospitals that provide comprehensive outpatient and inpatient services, and the other two are zonal and specialized hospitals that provide specialized services and give clinical training for nurses, health officers, generalists and specialists. A primary health care unit has been planned to serve 25,000 populations, districts and zonal hospitals are each expected to serve 250,000 and 1,000,000 population respectively while specialized hospitals are expected to serve 5 million populations (WHO-Co, 2005).

The number of health facilities and professionals are unmatched with the number of population. In 2004/5 the ratio of the population per hospital and per hospital beds is 557,584 and 5,290 respectively. The proportion varies extremely across regions. Harari (1:37,910) and Addis Ababa (1:90,238) are the leading regions while Amhara (1:1,034,780) and Oromia (1: 860,571) are the two regions, which have the highest proportion. The proportion of the population to health centers, health stations, health post, and private clinics are 121,739; 43,949; 17,346 and 46,289 respectively.

Table2.3.1 Health facilities population ratio by region, 2004/05

Region	Population ('000)	Health Facilities				
		Hopitals	Health Center	Health Station	Health Post	Private Clinic
Tigray	4,223.01	1:281,534	1:87,979	1:23,203	1:20,014	1:136,226
Afar	1,358.72	1:679,359	1:150,969	1:30,194	1:23,029	1:452,906
Amhara	18,626.05	1:1,034,780	1:147,826	1:465,651	1:13,108	1:61,270
Oromia	25,817.13	1:860,871	1:139,552	1:31,600	1:2,831	1:38,418
Somalia	4,218.30	1:703,050	1:263,644	1:56,244	1:34,862	1:210,915
Ben-Gumuz	609.51	1:304,755	1:55,410	1:10,884	1:9,377	1:32,079
SNNPR	14,489.71	1:852,336	1:89,998	1:56,600	1:11,010	1:124,911
Gambella	240.39	1:240,394	1:30,049	1:6,868	1:10,927	1:34,342
Harari	189.55	1:37,910	1:94,775	1:9,976	1:27,079	1:9,026
Addis Ababa	2,887.62	1:90,238	1:99,573	1:22,212	1:67,154	1:7,559
Dire Dawa	383.53	1:127,843	1:76,706	1:54,790	1:11,280	1:18,263
National	73,043.51	1:557,584	1:121,739	1:43,949	1:17,346	1:16,289

Source: MOH, 2005 and Own computation

When we look at the previous years trends all the proportions are gradually decreasing in every year. For instance, the proportion of the population per hospital was 594,036 in the period of 2000/01.This proportion has decreased by 6.5% when it is compared with the current proportion.

Table2.3.2 Health facilities population ratio of Ethiopia, (2000/01-2004/05)

Health facility	2000/01	2001/02	2002/03	2003/04	2004/05
Hospital	1:594,036	1:584,522	1:580,899	1:564,016	1:557,584
Health Center	1:171,058	1:163,155	1:153,275	1:136,929	1:121,739

Health Station	1:27,306	1:27,414	1:28,851	1:39,547	1:43,949
Health Post	1:63,875	1:51,274	1:48,273	1:24,514	1:17,346
Private Clinic	1:55,850	1:54,429	1:56,247	1:54,708	1:46,289

Source: MOH, 2005 and Own computation

On the other hand, the proportion of the population to physicians is 29,777 while to nurse is 3,883. This proportion has decreased by 37.8 and 54.1 percent compared with the 2000/01 proportions. However, World health organization (WHO) recommends that one physician to serve only 10,000 and one nurse to 5,000 populations. Thus, currently only the proportion of the population to nurses is in line with the standard of WHO.

Regarding the proportion of the population to physicians among regional states, only Harari has achieved the WHO standard (1: 4,623). Dire Dawa (1:12,784) and Addis Ababa (1:17,291) are next to Harari while Amhara (1: 142,184) and Oromia (1:138,802) have the highest proportion of population to physicians. Regarding the proportion of the population to nurses, all regions have achieved the standard of WHO except Afar, Amhara, Oromia, Somali and Southern Nations Nationalities and peoples (SNNPR) regions. The lowest proportion is in Dire Dawa (1 to 290) while the highest is in Somali (1 to 10,957).

Table2.3.3 Health professional population ratio by region, 2004/05

Region	Population ('000)	Health Professionals		
		Physicians	Nurses	Health Officer
Tigray	4,223.01	1:54,844	1:2,987	1:39,102
Afar	1,358.72	1:79,925	1:5,907	1:123,520

Amhara	18,626.05	1:142,184	1:9,294	1:161,966
Oromia	25,817.13	1:138,802	1:7,618	1:173,269
Somalia	4,218.30	1:76,696	1:10,597	1:281,220
Ben-Gumuz	609.51	1:43,536	1:2,200	1:50,792
SNNPR	14,489.71	1:136,695	1:6,203	1:122,794
Gambella	240.39	1:40,066	1:969	1:16,026
Harari	189.55	1:4,623	1:886	1:47,388
Addis Ababa	2,887.62	1:17,291	1:4,734	1:192,508
Dire Dawa	383.53	1:12,784	1:290	1:63,922
National	73,043.51	1:29,777	1:3,883	1:94,128

Source: MOH, 2005 and own computation

It can be noticed that the proportion of health facilities and professionals to the population are good in Addis Ababa, Dire Dawa and Harari which are predominantly urban while it is worse in Oromia and Amhara which are the two largest regions in the country that constitute most of the 85 percent of rural population of the county.

Health services are financed by the government (both federal and regional), bilateral and multilateral donors (both grants and loans), non-governmental organizations and private contributions. In the period 2000/01, the contribution of household and government was 36% and 33% respectively, while bilateral and multilateral contributed 16% (WHO-Co, 2005).

Total government budget allocation for the health sector has been increased at an annual average rate of about 15.05% during the last ten years (1995/96 to 2004/05). The per capita health spending doubled from 8.5 in 1995/96 to 16.8 in 2004/05. It has been increased at annual average rate of about 12.09% during the last ten years (1995/96 to 2004/05).

Table 2.3.4 Public health expenditure per capita, (1995/96-2004/05)

Year	Population ('000)	Health Expenditure ('000 Birr)	Per Capita
1995/96	4,223.01	481,950	8.5
1996/97	1,358.72	549,760	9.5
1997/98	18,626.05	671,174	11.2
1998/99	25,817.13	1,104,197	17.9
1999/00	4,218.30	575,112.5	9.1
2000/01	609.51	749,730	11.5
2001/02	14,489.71	757,100	11.3
2002/03	240.39	824,400	11.9
2003/04	189.55	910,588	13.2
2004/05	2,887.62	1,229,670	16.8

Source: MoH, 2005

Public health expenditure per capita highly varies among regions. In the period 2004/05, Harari (85.4),Gambella (49.9) and Benshangul-Gumuz (34.2) are the first three regions which have the highest per capita health expenditure while SNNPR (6.5), Oromia (6.9) and Somali (8.3) have the lowest per capita.

Both private and government spending has been increasing from US$ 4 to US$ 5.6 per capita. However, this is very low when it is compared with other Sub-Saharan African countries such as Kenya (US$31), Uganda (US$18) and Tanzania (US$ 8). Thus to meet the millennium development targets of US$ 34 per capita it requires significant increase in the current level of spending (WHO-Co, 2005).

2.4 QUALITY OF HEALTH SERVICES AND USER FEES

If user fees are adopted, it generates additional revenue, promotes efficient consumption, ration demand and improve targeting. Different researches have shown that patients are willing to pay considerably more than what they were already paying if the waiting time has reduced, if the availability of drugs and investigation services (laboratory tests) are guaranteed (Fairbank, 2001).

In Ethiopia it was in 1950's that cost recovery in the public health care system established. Since then user fees charged in government facilities have not changed. Apart from the low level of the charges the revenue generated from fee collections (since the majority of the population is granted exemptions and waivers) has declined.

The government has been issuing circulars to the Ministry of health (MoH) to provide free health care services to certain groups of society such as health service personnel, patriots, civil servants below a given level of income, prisoners, returnees and war veterans. A survey conducted at ten hospitals and ten health centers indicated that the percentage of waived and exempted patients was 66%.This shows that health facilities in Ethiopia are providing health services with out charging fees for the majority of the population (HCFS and ESHE, 2003).

However, due to shortage of drugs and supplies in the public health facilities, poor patients often pay higher prices in the private facilities for drugs and laboratory services and those who live far from the health facilities have to pay for transportation and accommodation. Thus, fee waiver certificates do not necessarily ensure delivery of services to the poor.

Outpatient registration fee and bed fees per day with meals varies among hospitals. On average government hospitals charge five birr for outpatient registration and consultation while private hospitals charge 40 birr. Bed fees per day with meals for first class is birr 5 for government hospitals and birr 233 for private hospitals, for the second-class birr 3 for government and birr 188 for private hospitals and for third class birr 2 for government and birr 150 for private hospitals. Besides the low level of fee collection, the fees collected by government health facilities are remitted to the government as general government revenue. This creates dis-incentive in fee collection (Fairbank, 2001).

In order to increase the resources available for the health sector, the government launched a health financing reform strategy in 1998. The strategy includes adjusting user fees at government health facilities to increase revenue and to use resources efficiently and allows health facilities to withhold retention from collected fees. It identified as waiver of fees shall be granted only for patients diagnosed as having certain communicable diseases and for patients whose household income is below the poverty level. The ministry of health developed drafts of the health service delivery and management proclamation and associated regulations aiming at properly guiding the implementation of the health care financing reform. Currently, only one region (SNNPR) has developed and ratified its own proclamation and regulations and has implemented fee retention in its hospitals. However, the proclamation and regulations have yet to be approved by regional governments and the Federal Parliament to be applied by other public hospitals (Fairbank, 2001; WHO-Co, 2005).

III REVIEW OF RELATED LITERATURE

3.1 MEASUREMENT OF HEALTH CARE

In the health facilities, efficiency focuses on the relation between resource inputs such as labor, capital or equipment and either intermediate outputs (number of patient treated, waiting time etc) or final health outcome (life saved, life years gained etc). Ideally, health care evaluations should focus on final health outcomes rather than on throughputs or intermediate outputs.

Clewer and Perkins (1998) argued that measuring efficiency using intermediate outputs or by examining the intensity of capacity utilization is not appropriate because it focuses on process rather than outcomes. In other words, the output should be the number of life saved, life years gained, the improvement in health or the relief of suffering in those patients treated than the number of patients treated, average length of stay or bed occupancy rate.

However, the output of a hospital service is determined by the behavior of a patient, the availability of adequate treatment or on certain external factors that are beyond the control of a physician / a hospital. A brilliant physician having all the available resources may not be able to save the life of his patient if the body of the patient does not react as expected. Moreover, due to the fact that it is too difficult to measure final health outcomes (how the patient's health has improved), researchers have been using measures of throughputs or intermediate outputs (Palmer and Torgenson, 1999; Wang and Mahmood; Bernades et al, 2004).

3.2 EMPIRICAL LITERATURE

3.2.1 GENERAL

Varatharajan (1999) reviewed the experience of 27 countries to improve the efficiency of public health care units in Tamil Nadu (one of the state of India). According to the researcher, due to financial and organizational problems the performance of health care infrastructure is lower in the state.

He concluded that the performance of the financial and organizational choices in the reviewed countries showed a single choice frame work does not work to improve efficiency.

A package-based health care system appropriate to the local community is recommended and enhancing the productivity of the manpower improves efficiency. However, the limitation of the study is that it did not use any methodology to show the degree of the (in) efficiency of the health care units.

Somanathan et al (2000) examined efficiency of public sector health facilities. They surveyed 218 health facilities. Out of which, 20 case studies were undertaken. They applied both quantitative (ratio measures, average costs, and estimation of cost and production functions) and qualitative measurement technique (interview).They concluded that using unit costs, average lengths of stay and occupancy rate indicators the Sri Lankan health sector is relatively more efficient in the cross-country comparison.

However, the researchers compared the countries using samples in different time period and also for some countries including Sri Lanka they used a one time period sample, which might led to bias due to extreme observations.

Farsi & Filippini (2004) have investigated cost efficiency in non-profit and public nursing homes in Switzerland. They examined the effect of ownership and institutional form on the production costing using a panel data of 17 public and 19 non- profit nursing homes operating over the nine years period. The effect of institutional form on efficiency is tested using a Translong Stochastic Cost Frontier model. They found that non-profit foundations are more cost efficient than government administered nursing homes.

Kiriga et al (2004) measured technical efficiency of 32 public health centers in Kenya using DEA. They used six inputs and four outputs. The inputs include: Clinical officers and nurses;

Physiotherapists, Occupational therapists, dental technologists, public health officers; laboratory technologists and technicians; Administrative staffs; Non-wage recurrent expenditures and number of beds. Outputs include: Diarrhea, Malaria, Sexual transmitted infections (STI), Urinary tract infection, Intestinal worm and respiratory disease visits; Antenatal and family planning visit; Immunization visit and other outpatient visit. The result indicated that 44% of the health centers found technically inefficient and 41% of them were scale inefficient. To improve the problem of inefficiency, they suggested to transfer, decrease or sell excess inputs and create demand to increase output.

However, since they used a one time period data the results might be biased and their suggestion of selling excess inputs is inappropriate due to the fact that in most developing countries there is shortage of health care resources.

Renner et al (2005) measured the technical and scale efficiency among a sample of 37 peripheral health units in Sierra Leone. They used a one time period sample data and employed Data Envelopment Analysis. Inputs include: technical staff and subordinate staff while outputs include: ante-natal and post-natal visits, child deliveries, nutritional/child growth monitoring visits, family planning visits, immunized children and pregnant women and total number of health education sessions. They found that, 22(59%) were technically inefficient and 24(65%) are scale inefficient. The main limitation of the study was that the sample data. Since they used a single time period data this might led to bias due to extreme observations.

3.2.2 STUDIES CONDUCTED USING STOCHASTIC FRONTIER APPROACH

Wang and Mahmood (1999) investigated relative efficiency of 51 large and 62 small acute public hospitals in Australia. They applied a Stochastic Frontier Cost function analysis using a one time period cross-section sample. They used inpatient case mix and occasion of services as an output while variable costs (salaries of medical and non-medical staffs) as input and also used number of beds as a proxy for fixed inputs.

The result indicated that technical inefficiencies are 11.3% and 9.3% for small and large acute hospitals respectively and dis-economies of scale existed in some very large hospitals while scale economies in some very small hospitals. However, besides the sample data was being a one time period the researchers admitted that the regression sample is too small and this imposes severe constraints on the estimation process.

Yong and Harris (1999) examined efficiency of 35 Victorian public hospitals in Australia. They used total output expenditure as dependent variable. Weighted Inlier Equivalent Separations (WIES) - the sum of all discharges adjusted for variability -, on campus medical/clinical occasions of service, emergency/causality occasions of service and wages of medical doctors as explanatory variables.

They applied both OLS and Stochastic Frontier Approach (SFA) to obtain the (in) efficiency scores. The inefficiency scores obtained from SFA regressed against factors which likely to determine the efficiency of hospitals (occupancy, size and medical staff per WIES) using Tobit model.

The results obtained in the OLS regression indicated that teaching hospitals have significantly higher costs than other hospitals in the sample, while the SFA result showed the mean cost inefficiency is around 3% in total operating expenditure.

3.2.3 STUDIES CONDUCTED USING DATA ENVELOPMENT ANALYSIS

Starting from its development Data Envelopment Analysis has been extensively used for efficiency measurement of health facilities. Following, some of the empirical literatures conducted on hospitals and heath centers will be reviewed.

Linna and Hakinnen (1997) investigated determinants of cost efficiency of 48 acute care Finnish hospitals. They used cross-sectional data of a one-time period and employed both DEA and Stochastic Frontier Analysis (SFA) using four outputs and three inputs. The outputs were outpatient treatment, inpatient treatment, teaching and research variables, while doctor's working hours, other employees' working hours and costs of materials and equipments taken as inputs. They used a two stage estimation procedure. After calculating efficiency scores for each hospital using DEA and SFA, the scores were regressed on a number of factors that affect the observed (in) efficiencies. The SFA scores examined using OLS regression, while the DEA scores using censored Tobit model. Results of the study revealed that, 63% of all hospitals scored technical efficiency score of 1 in the VRS and 40% in the CRS models. They concluded that half of the inefficiency was due to technical while half of it due to allocative inefficiency. According to them; specialization, share of physicians and proportion of resident physicians to all physicians were affected cost efficiency.

The main limitation of the study was that the number of output and input variables was large for the sample size that might have resulted 63% of all hospitals to score the highest technical efficiency score in VRS model.

Parkin and Hollingsworth (1997) measured production efficiency of 75 Scottish acute hospitals. They used a three years sample data and employed Data Envelopment Analysis. The outputs were: acute discharges (medical), acute discharges (surgical), accident and emergency attendances, outpatient attendances, obstetrics and gynecology discharges, and others specialty discharges. The inputs were: average numbers of staffed beds, total number of trained, learning and other nurses, total number of professionals, technical, administrative and clerical staff, total number of junior and senior non- nursing medical and dental staff, cost of drug supply and hospital's capital charge. They identified four models employing different combination of inputs and outputs in order to compare the results. Moreover, examining the results obtained in the three years, internal and external validity were assessed.

The researchers found that there was inconsistency between the different results obtained and suggested that caution must be taken while employing DEA particularly on a single time period.

In 2000, Gruca and Nath examined the technical efficiency of 168 community hospitals in Ontario to investigate the impact of ownership, size and location. They used a one time period sample data and inputs include full time equivalent (FTE) of nursing, full time

equivalent Ancillary service (services of laboratory, pharmacy, radiology and physical therapy), Administration (FTE), Services and Supplies including drugs and medical- surgical supplies and Number of beds. Outputs include inpatient cases weighted by resource intensity weights, weighted outpatient visits and long-term days of care.

They formulated two DEA models. 'Pooled' model in which all hospitals are compared to each other and the other one was 'Nested' model in which the efficiency scores of all hospitals computed in two steps. Firstly, hospitals without long term health care facilities compared to each other. In the second step, hospitals that have long term care facilities are compared to each other and with those without long-term care. They found that there are no significant differences in efficiency across ownership types (government, religious or secular non- profit), size differences or location (urban, sub-urban or rural).

The main limitation of the study was that its sample data. They used a one time period data set this might led to bias due to extreme observations.

Eyob (2000) investigated technical efficiency and productivity of 86 public hospitals in three provinces of South Africa using DEA and DEA –based Malmquist Productivity Index (MPI). He used recurrent expenditure and bed- size as input, while inpatient days and out patient visits as outputs. He classified the hospitals in to three levels based on their bed size and the services they provide and used Tobit regression model to identify factors that affect (in) efficiency.

The result indicated that overall technical efficiency differ among hospitals in each group. Using the Tobit model, he found that bed occupancy rate positively affected the overall technical efficiency whereas average length of stay did not have a significant effect. However, his finding regarding the impact of average bed occupancy rate rejected by other researchers. Jacques and Steven (2002) argued that bed occupancy (Average bed occupancy rate (ABOR)) is a ratio that can be easily manipulated and increased and concluded that it is inadequate and unreliable determinant of efficiency for public hospitals in South Africa.

Barbetta et al (2001) evaluated technical efficiency of 800 Italian public and non-profit hospitals using a panel data of four years. They applied both parametric (Corrected Ordinary Least Square (COLS)) and non- parametric (DEA) out put Oriented) approaches. In the case of DEA they found opposite results. On average, public hospitals are more efficient when discharged patients considered as output while non profit hospitals are more efficient when length of stay considered as output. However, the result of COLS showed that public hospitals are more efficient than non-profit organizations

In 2003, Steinmann et al measured and compared the efficiency of hospitals in Germany and Switzerland employing DEA. Academic staff, administrative staff, expenses, patient days and number of beds were taken as inputs, while number of cases treated in five hospital departments (medical, pediatric, Gynecological, surgical and intensive care) taken as an output. Results of the DEA estimation identified Germany hospitals have higher efficiency score than the Swiss hospitals.

Pvananunt (2004) investigated technical efficiency of 662 public community hospitals in Thailand. They have included labor input (payroll of personnel taken as proxy), total annual capital expenditure and medical and non-medical expenses as input. Inpatient days, Outpatient, accidental and emergency visits were taken as output. He used a five-year panel data and employed a Cobb-Douglas production function by applying fixed effect model approach. To identify factors affecting the technical efficiency, he regressed the efficiency scores against external factors (location, size of population and availability of other health facilities) and internal factors (technology, size, age, managing service, managing human resource and managing financial resource) using multiple regression analysis. He found that, large sized hospitals were more efficient than the small sized hospitals and the internal factors were significantly affecting the technical efficiency scores.

However, other researchers opted for using either depreciation of capital (equipments, buildings etc) or recurrent expenditure than using capital expenditure. The argument behind excluding capital expenditure is that the capital cost incurred in a period may transgress to future years. Put differently, although the capital is bought in the sampling period its productivity may transfer out of the sampling period.

Osei et al (2005) examined the technical efficiency of 17 public hospitals and 17 health centers in Ghana. They used a one time period data set employing DEA. Number of maternal and child care, deliveries and number of patients discharged used as outputs while number of medical officers, number of technical officers(medical assistants, nurses and paramedical staff),administrative staff and number of hospital beds used as input. They found that, 8 (47%) hospitals are technically inefficient while 10 (59%) are scale inefficient.

However, the main limitation of the study was its data set. They used a one time period data set, which might lead to bias due to extreme observations.

In the Ethiopian case no study has been conducted using DEA to measure the efficiency of hospitals. However, Getachew (2002) employed Stochastic Frontier Analysis to measure the technical efficiency of 8 selected public hospitals in Ethiopia. He used two outputs and five inputs to estimate the contribution of each input in the production process of health output. The outputs were outpatient visit and inpatient visit, while labor time spent by different professionals and administrative staffs, budget allocated to drugs, number of beds and depreciation of capital (building). He disentangled the labor time into labor time of technicians and labor time of administrative staff and finally formulated the inefficiency model using salary of technical and non-technical staffs as its determinants.

The estimation conducted using outpatient visits as an output, showed three hospitals exhibited some degree of technical inefficiency, while the estimation conducted using inpatient visit as an output indicated as one hospital exhibited inefficiency.

During the same period, Tamiru (2002) examined the technical efficiency of 40 health centers in Ethiopia. He employed DEA model for a one year data set to obtain the efficiency scores and regressed the efficiency scores against health center operating characteristics using both OLS and Logit models. For inputs he used: Doctors/ health officers, Nurses, Health assistants, other technical staffs and Administrative staff while for outputs he used: Outpatient visits, maternal & child care visits & delivery services.

The DEA results indicated that, 62.5% of the health centers were technically inefficient and 60% were scale inefficient while the OLS and Logit results showed that location and availability of hospitals in the area significantly affected level of efficiency.

The main weaknesses of the two studies were their data set. Moreover, although the efficiency scores were continuous numbers, the second study employed Logit model in the second stage. Thus, measuring technical efficiency using a single time period data (due to extreme observations) and employing Logit model might lead to bias results. However, to mitigate these problems our study was carried out using a five year panel data and determinants of efficiency were examined using censored-Tobit regression model.

IV METHODS, SPECIFICATION OF THE MODEL AND THE DATA

4.1 METHODOLOGICAL LITERATURE

Parametric approach (statistical approach) and the non- parametric approach are the two main approaches used to estimate relative efficiency among firms. The main difference between the two approaches lies on the specification of the functional form. The parametric approach specifies a particular functional form while the non- parametric does not. The other difference is due to their techniques. The parametric approach uses econometric techniques. Simple regression analysis and Stochastic Frontier Analysis (SFA) are the two best examples. On the other hand, the non- parametric approach uses mathematical programming techniques. Simple technique of index numbers and Date Envelopment Analysis (DEA) are the two best examples of this approach (Sarafidis, 2002).

Forsund et a1 (1980) have classified the studies of frontiers in to deterministic and non-deterministic approach. They further categorized the deterministic frontiers in to non-parametric frontiers, parameter(ic) frontiers and statistical frontiers. This classification is based on adding slight assumption in each category. According to them the stochastic frontier is categorized under the non- deterministic approach.

4.1.1 CONCEPTS AND MEASUREMENT OF EFFICIENCY

Modern efficiency measurement was introduced by Farrell (1957) using the work of Debrue (1951) and Koopmans (1951). He suggested a measure of productive efficiency of a firm

that avoids the problems associated with traditional average productivity measures. According to him, efficiency is measured relative to a best-performance frontier that is determined by a representative peer group. Put differently, a firm's efficiency is measured relative to the efficiency of all other firms in the industry and it will be technically efficient if it operates on the best practice production frontier in the industry (Abrar, 1995; Eyob, 2000).The following discussion is adopted from Coelli (1996) and Eyob (2000) to illustrate Farrell's basic idea.

INPUT-ORIENTED MEASURES

It focuses on the measurement of variations in input use and an increase in efficiency will be achieved by reducing inputs proportionally holding outputs constant. Suppose under the assumption of constant returns to scale a hospital use two inputs (number of doctors and hospital beds) to produce a single output (outpatient visit). A hospital is technically efficient if it is operating on the isoquant II' (figure 1). On the other hand, hospitals operating at point P and T are technically inefficient. If a given hospital uses its inputs to produce a unit of output operating at point P the distance QP could represent its inefficiency.

The technically efficiency of a hospital working at point P is measured by the ratio:

TE=OQ/OP

Technical efficiency will take a value between zero and one. Hence, a value of one indicates the hospital is fully efficient while a value less than one indicates the hospital is inefficient.

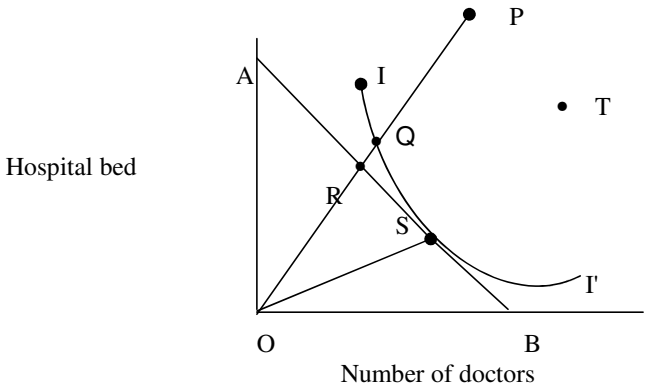


fig. (1) technical and allocative efficiency of input orientated measures

We can also calculate allocative efficiency if the input price ratios are given that is represented by AB (isocost line). Allocative efficiency takes place at the point where the isoquant is tangent to the isocost line. Thus, even if hospitals producing at points Q and I are regarded as technically efficient they are allocatively inefficient.

The allocative efficiency (AE) of a hospital operating at point P is measured by the ratio:

$$AE = OR/OQ$$

The distance RQ or the ratio RQ/OQ represents the reduction in production costs that would occur if production were to occur at the allocatively and technically efficient point S than only at the technically efficient point Q.

Farrell (1957) suggested that both technically and allocatively measures together give a measure of overall (economic) efficiency and measured as:

$$EE = OR/OP$$

In other words, the product of technical and allocative efficiency gives the overall (economic) efficiency

$$TE * AE = EE = OR/OP = OQ/OP * OR/OQ$$

Similar with technical efficiency score both allocative and overall (economic) efficiency lies between zero and one.

OUTPUT-ORIENTED MEASURES

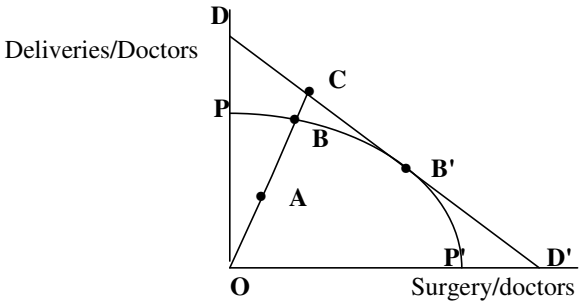
It focuses on the measurement of variation in output produced and an increase in efficiency will be achieved by increasing outputs proportionally holding the input quantities constant. Suppose under the assumption of constant returns to scale a hospital use one input (number

of medical doctors) to produce two outputs (Delivery and Surgery). A hospital is technically efficient if it is operating at point B of the unit production possibility curve while a hospital operating at point A is technically inefficient. This is because at point A it is possible to increase output with out requiring extra inputs (figure 2).

The technical efficiency of a hospital working at point A is measured by the ratio:

$$TE = OA/OB$$

It is also possible to calculate allocative efficiency if the input price ratios are given that is represented by DD' (isorevenue line). Allocative efficiency in this case will be held at the point where the isorevenue line is tangent to the production function. Hence, although a hospital operating at B is technically efficient it is allocatively inefficient. However, hospitals operating at point B' are both technically and allocatively efficient.



fig(2) technical and allocative efficiency of output oriented measures

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The allocative efficiency (AE) of a hospital operating at point **A** is measured by the ratio:

$$AE = OB/OC$$

The distance BC or the ratio BC/OC represents an increase in revenue that would occur if production were to occur at the allocatively and technically efficient point B' than only at the technically efficient point B.

The overall (economic) efficiency will be measured by:

$$TE * AE = EE = OA/OC = OA/OB * OB/OC$$

Under constant returns to scale the input and output oriented measures provide equivalent measures of technical efficiency unlike the case of increasing or decreasing returns to scale.

4.1.2 APPROACHES USED TO MEASURE EFFICIENCY

A number of different measurement techniques have been used to measure efficiency of heath care services and systems. Following, some of the most frequently used ones will be

discussed based on the discussion of Coelli (1996), Eyob (2000), Talluri (2000) and Sarafidis (2002).

RATIO MEASURES

It is the simplest way of measuring efficiency. Some of the methods used to measure efficiency are number of outpatient visits per health worker, consumption of drugs and supplies per health worker and average ratio. The main advantages of such ratios are they can be easily calculated thereby one can easily identify whether health facilities perform poorly or not. However, they can be easily manipulated and increased. Moreover, they focus only on a single type of hospital activity and can not handle multiple input and output.

SIMPLE REGRESSION ANALYSIS

It applies Ordinary Least Squares (OLS) for estimating production or cost functions and thereby to measure relative efficiency among firms. To measure relative efficiency, the following two steps will be sued. First, a simple regression model is formulated to identify the relationship that best fits the observed data. In the second step, the residuals of the estimated regression (the difference between the actual and the predicted) would be taken as measures of inefficiency (Sarafidis, 2002).OLS and Corrected Ordinary Least Square (COLS) can be taken as best examples of simple regression analysis.

The OLS regression model can be written as follows:

$$y_i = f(x_i, \beta) + U_i$$

Where y_i - denotes the actual output level

x_i - is a vector of inputs

β - a vector of parameters to be estimated

U_i - is the estimate of inefficiency for firm i

Its main advantage is that it is computationally easy and straightforward. It can easily estimate the institutional and environmental factors that influence firms' efficiency. The main drawback for both OLS and COLS is that the residuals in the estimation do not only reflect inefficiency. It reflects relative efficiency, measurement error in the dependent variable and statistical noise. The other limitation is that both OLS and COLS are subject to theoretical objections. The OLS method does not calculate a frontier that is similar to the original function. It calculated a fitted average function that provides no direct information on inefficiency in the sample. Moreover, the regression analysis is also vulnerable to statistical problems. The residual depend on the explanatory factors thereby the estimators are biased, measuring explanatory factors with error results in the estimators to be biased and inconsistent.

STOCHASTIC FRONTIER ANALYSIS

Prior to the Stochastic Frontier development, all frontier methods used to measure efficiency were deterministic approach. In the deterministic approach all variations in the performance of firms is due to variations in efficiencies. The approach did not consider other factors (such as poor machine performance, bad weather, input supply breakdowns etc) which might affect performance of firms (Forsund et al, 1980).

However, the Stochastic Frontier model specifies a production function and any deviation as measured by the error term constitute two parts. The first one is asymmetric component (denoted by **v**) which captures measurement error, other statistical noise and random shocks outside the control of the production unit. The other part (denoted by **u**) represents the effects of inefficiency (Forsund et al, 1980; Croppenstedt and Abbi, 1996; Worthington, 2004).
The Stochastic production Frontier model can be written as follows:

$$Y_i = f(X_i, \beta_k)\ e^{vi-ui}$$

Where: y_i denotes the actual output level

x_i is a vector of inputs

β_k is a vector of k parameters

exp($\mathbf{V_i}$) captures random effects of measurement error& exogenous shocks

exp($-U_i$) captures technical inefficiency related to the stochastic

Production function.

The estimates of the model can be obtained either using Maximum likelihood or Corrected Ordinary Least Square (COLS) methods after the distribution of U is specified (Forsund et al, 1980).

Among the advantages of SFA are it recognizes the presence of errors and separate the error term from the measures of inefficiency; it gives some statistical inference to the functional form of the frontier and the significance of individual explanatory factors upon the shape of the frontier and it attempts to determine the absolute efficiency of firms against some imposed benchmark (Sarafidis, 2002).

However, separation of the error components from the measure of inefficiency is not always successful. When the estimated inefficiency component represents a small fraction of the overall residual variation, the SFA will vulnerable to outliers. The outliers can cause the SF model to perceive that there is too much noise in the data and therefore may find little or no inefficiency in the sample even if it does. Moreover, if the model uses maximum likelihood estimation there is no guarantee that the final estimators will hold any desirable statistical properties (unbiased ness, efficiency, consistency) in small samples. It is also subject to theoretical objections. The model commonly uses the half –normal and the exponential distribution. These distributions assume a large number of relatively efficient firms and only few inefficient firms in the industry. However, in practice most of the firms might be relatively inefficient.

To mitigate the last problem the truncated-normal and the gamma distributions are developed. However, there is no a priori theoretical justification for selecting any of the distributions and the estimates of inefficiency may be sensitive to these alternative specifications.

DATA ENVELOPMENT ANALYSIS

Farrel's technically efficiency can only apply to firms aim a single goal .It cannot apply to firms to aim multiple goals. Hence, Charnes et al (1978) extended Farrel's efficiency concept. They reformulated as a mathematical programming approach to efficiency measurement and described it Data Envelopment Analysis (DEA). They used the input orientation approach and assumed constant returns to scale. However, Banker et al (1984) considered a variable returns to scale model.

DEA involves the use of linear programming methodology to evaluate relative efficiency of each production unit among a set of fairly homogenous decision-making units. It constructs a production possibilities frontiers (data envelop or efficient frontier) over the data (Inputs and outputs) to calculate efficiencies relative to this frontier. In the context of health facilities, those which are regarded as technically efficient compared to their peers will have an efficiency score of 1(100%) while the inefficient health facilities will score between zero and one (Osei et al, 2005) . It can be solved using either the assumption of constant returns to scale (CRS) or variable returns to scale (VRS).

The CRS assumption is appropriate only for hospitals that are operating at an optimal scale. In a situation where hospitals are not operating at an optimal scale the technical efficiency measure will be mixed with scale efficiency. Hence, to separate the two inefficiency scores it is opted for applying variable returns to scale (VRS).

The difference between the CRS and VRS production frontiers can be explained using the following figure (figure 3).

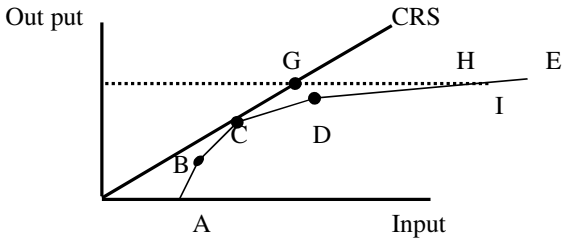

fig (3) CRS & VRS production frontiers (parking and Hollingsworth ,1997).

Hospitals between **A** and **C** are technically efficient and have increasing returns to scale while hospitals between points **C** and **E** are technically efficient but have decreasing returns to scale. On the other hand, hospitals at point **C** are scale efficient on both CRS and VRS. The frontier **ABCDE** indicates the VRS frontier. Hospitals at point **I** are both technically and scale inefficient. It needs the input combination **H** to be technically efficient and **G** to be both technically and scale efficient (Parkin and Hollingsworth, 1997).

Among the advantages of DEA are since any deviations from the estimated frontier is interpreted as due to inefficiency random noise is less of a problem, it handles multiple input and multiple output models and functional form of relating inputs to outputs is not required. Moreover, when price data is difficult to get and when units of input and output are different it is preferred to use DEA.

On the other hand, DEA has two main limitations. First, it is non- stochastic since it does not capture random noise. It attributes any deviation from the estimated frontier as being due to inefficiency but some of the deviations could be due to statistical noise (such as epidemics, weather, and strike) or measurement errors. Second, it is non- statistical. It does not allow conducting statistical tests of hypothesis for both the inefficiency and the structure of production function (Eyob, 2000; Osei et al, 2005).

However, Ferrier and Valdmanis (1996) argued that the limitations are not as such serious. According to them, since there is no a priori specification of the functional form of the technology, the first limitation will be ruled out and since input and output are measured in their natural physical units the second limitation will be solved (Eyob, 2000).

DEA-LIKE MALMQUIST MODEL

This model applies for panel data and calculates indices of total factor productivity (TFP), technological, technical efficiency and scale efficiency changes. It also allows the decomposition of productivity change in to technical change and efficiency change.

However, to obtain relative (in) efficiency scores of hospitals this study opted for employing DEA instead of the other approaches for the following reasons. First, in the production process hospitals employ multiple inputs to produce multiple outputs. The inputs and outputs have different units of measurement and also difficult to relate them using a functional form. Second, it is difficult to obtain information on prices of all inputs and outputs of hospitals. However, since these two problems are handled by DEA it is preferred to use it in this study.

4.2 MODEL SPECIFICATION

SPECIFICATION OF THE DEA MODEL

Different researchers used different DEA model specification to examine technical efficiency of hospitals, albeit their final analysis is made using the DEAP software. In this study the model adopted is based on Eyob (2000); Talluri (2000); Osei et al (2005) and many others model specification that are applied in the health sector.

4.2.1 THE CONSTANT RETURNS TO SCALE (CRS) MODEL

The efficiency score of a decision making units which employs multiple input and output is defined as:

$$Efficiency = \frac{weighted\ sum\ of\ outputs}{Weighted\ sum\ of\ inputs}$$

The relative efficiency score of hospital **p** can be solved by using the following model:

$$Eff = Max \frac{\sum_{r=1}^{s} U_r Y_{rp}}{\sum_{i=1}^{m} V_i X_{ip}}$$

$$S.t \quad \frac{\sum_{r=1}^{s} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}}$$

$$U_r, V_i \geq 0 \quad ; \quad \forall_r, \forall_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The functional programming model of equation (1) can be converted to a linear programming model by introducing the following constraint:

$$\sum_{i=1}^{m} V_i X_{ip} = 1$$

Thus, the relative efficiency score of hospital p can be obtained by solving the following equation:

$$Eff = \underset{U_r, V_i}{Max} \sum_{r=1}^{s} U_r Y_{rp}$$

$$S.t : \sum_{r=1}^{s} U_r Y_{rj} - \sum_{i=1}^{m} V_i X_{ij} < 0 \; ; \; \forall_i$$

$$\sum V_i X_{ip} = 1$$

$$U_r, V_i \geq 0; \forall_r, \forall_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

r = 1 to S

i = 1 to m

j = 1 to n

p = the hospital under assessment

Y_{rj} = the amount of output r produced by hospital j

X_{ij} = the amount of input i used by hospital j

U_r = the weight given to output r

V_i = the weight given to input i

The first constraint implies that all hospitals are on or below the frontiers while the second constraint implies that the weighted sum of inputs for the particular hospital equals one.

4.2.2 THE VARIABLE RETURNS TO SCALE (VRS) MODEL

It is already stated that the CRS assumption is appropriate only to hospitals operating at an optimal scale. In a situation where hospitals are not operating at an optimal scale, the technical efficiency measure will be mixed with scale efficiency. Hence, to separate the two efficiency scores variable returns to scale (VRS) model is considered. VRS is an extension of equation 1 of the CRS model after imposing a convexity constraint on it. This means that the data are enveloped more closely than the CRS model. The main advantage of the VRS model is that it enables an inefficient firm to be relatively compared with efficient firms of the same size only.

Thus, the relative efficiency score of hospital p can be obtained by solving the following equation:

$$Eff = \underset{U_r, V_i}{Max} \sum_{r=1}^{s} U_r Y_{rp} + U_0$$

$$S.t: \sum_{r=1}^{s} U_r Y_{rj} - \sum_{i=1}^{m} V_i X_{ij} + U_0 \leq 0 \qquad ; \qquad \forall_i$$

$$\sum_{i=1}^{m} V_i X_{ip} = 1$$

$$U_r, V_i \geq 0; \qquad \forall_r, \forall_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Where: Uo is the convexity constraint and its sign determines the returns to scale. If Uo < O it indicates increasing returns to scale, if Uo > 0 it is decreasing returns to scale and, if Uo = O it is constant returns to scale. The other notations are as given in the case of CRS model.

The difference between the efficiency scores of CRS and VRS DEA models show scale efficiencies of hospitals. The scale efficiency is equal to the ratio of the CRS technical efficiency to the VRS technical efficiency. A hospital exhibiting decreasing returns to scale should scale down both its outputs and inputs to operate at its most production scale size and if it exhibits increasing returns to scale, it should expand both its inputs and outputs.

4.2.3 DEA-LIKE MALMQUIST MODEL

The CRS and VRS DEA models are suitable to measure technical efficiency of firms observed in a one time period. Moreover, in the case of panel data, the two models provide technical efficiency score of each time period separately. However, each time period sample data should be solved separately to obtain each year's efficiency score. Therefore, it is opted for the DEA-like Malmquist model to obtain the DEA efficiency scores of all the sample periods observations simultaneously. The scores were used as dependent variable and regressed against determinants of (in) efficiency.

Malmquist DEA model applies for panel data and calculates indices of total factor productivity (TFP) change, technological change, technical efficiency change and scale efficiency change.

The output based Malmquist productivity change index of Fare et al (1994) is specified as follows:

$$M_o\left(y^{t+1}, x^{t+1}, y^t, x^t\right) = \left[\frac{D_o{}^t\left(x^{t+1}, y^{t+1}\right)}{D_o{}^t\left(x^t, y^t\right)} x \frac{D_o{}^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_0{}^{t+1}(x^t, y^t)}\right]^{1/2} \quad \text{..... (4)}$$

Where:

M_o measures productivity of the production point (x^{t+1},y^{t+1}) relative to the production point (x^t,y^t)

$D_0{}^t(x^{t+1},y^{t+1})$ represents the distance from the period ***t+1*** observation to the period ***t*** technology

$D_0{}^{t+1}(x^t,y^t)$ represents the distance from period ***t*** observation to the period ***t+1*** technology.

If the value of M_o is greater than one, it shows the existence of positive total factor productivity from period t to period t+1 while a value less than one indicates a decline in total factor productivity.

Further decomposition of equation (4) provides measures of efficiency change and technical change separately.

$$Mo\left(y^{t+1}, x^{t+1}, y^{t}, x^{t}\right) = \frac{D_o^{\,t}\left(x^{t+1}, y^{t+1}\right)}{D_o^{\,t}\left(x^{t}, y^{t}\right)} \; x \quad \left[\frac{D_o^{\,t}\left(x^{t+1}, y^{t+1}\right)}{D_o^{\,t}\left(x^{t}, y^{t}\right)} x \frac{D_o^{\,t+1}\left(x^{t+1}, y^{t+1}\right)}{D_o^{\,t+1}\left(x^{t}, y^{t}\right)}\right]^{1/2} \quad \text{…….. } \textbf{(5)}$$

The first term measures efficiency change while the second term measures technical change in the two periods. An improvement of efficiency occurs from period t to period t+1 if the ratio is greater than 1(one).

Although the choice of the orientation does not affect the results significantly, the input-oriented DEA model is preferred to estimate the CRS DEA and VRS DEA models due to the fact that hospitals; particularly private hospitals, could control more their inputs than their outputs. In the two models, average of the five years data were used in order to avoid biases due to extreme observations while the DEA-like Malmquist model is analyzed using the panel data. A DEA score of 1(100%) shows a hospital is relatively efficient than other hospitals in the sample, while efficiency scores less than 1(100%) indicates a hospital is relatively inefficient. All the three models solved using DEAP Version 2.1 DEA computer program software developed by Coelli (1996).

4.3 SPECIFICATION OF THE DEA MODEL

The (in) efficiency scores obtained from the DEAP software suffices to identify whether a particular hospital is technically efficient or not. However, there are institutional and environmental factors that are beyond the control of managerial actions. To examine how these factors affect the (in) efficiency of hospitals, the DEA efficiency scores were analyzed by regressing them against some characteristics of the hospitals. Since the dependent variable (efficiency scores) is continuous between one and zero, we could not apply the Logit model and since the efficiency scores are bounded from above at one using OLS model result in a biased result. Thus, we opted for using a censored Tobit model to overcome the stated problems.

To examine the DEA scores against the stated (in) efficiency determinants, the adopted model is based on Eyob (2000) and Linna and Hakinnen (1996) model specification. Like these two studies, this study transforms the DEA scores in to inefficiency scores using the following formula:

$$\textit{Inefficiency score} = (1/\textit{DEA score})-1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

The model is specified in the following form:

$$y_i^* = \beta_i x_i + u_i$$

$$y_i = y_i^* \text{ if } y_i^* > 0$$

$$y_i = 0 \text{ if } y_i^* \leq 0$$

Where $u_i \sim N(0, \delta^2)$, and

y_i **is the observed inefficiency score**

β_i **is a kx1 vector of unknown parameters**

x_i **is a kx1 vector of explanatory variables**

Therefore the empirical regression model is specified as:

$$INEFF = \alpha_0+\beta_1 Age+\beta_2 LSize+\beta_3 LSize^2+\beta_4 Own + \beta_5 Teacstat + \beta_6 linpddoc+ \beta_7 Abor + \beta_8 Docstaff +\varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The Variables in the model are defined as follows:

INEFF: Derived inefficiency scores from equation (6)

Age: Length of time or years in operation included in the analysis.

Size: Average numbers of beds are taken as a proxy to measure hospitals' size. To reduce its correlation with the beds taken as input in the DEA analysis through the efficiency scores, its natural logarithm and its squared value is (due to its non-linear relationship with efficiency) also included in the analysis(Diacon,2001).

Own: ownership dummy variable. It is 1 if the hospital is public and 0 if it is private hospital

Teachsta: It is teaching status dummy variable. It is 1 if it is teaching hospital and 0

otherwise.

Linpddoc: It represents natural logarithm of inpatient days to doctors. It is the proportion of inpatients (proxied by inpatient days) treated per medical doctors. Like the case of the variable size, since inpatient days are taken as output in the DEA model, its natural logarithm has also been taken to reduce correlation problem.

Abor: It is an average bed occupancy rate and measured by the total length of stay is divided (inpatient days) by the hospital bed.

Docstaff: It represents proportion of doctors to staff. This variable is measured by the total number of medical doctors divided by the total staff of the hospital.

α_0, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ and β_8 are Coefficients to be estimated, and ε_i is the random disturbance term.

4.4 DATA TYPE, SOURCES AND DESCRIPTION

The study measured technical efficiency of seventeen hospitals. The set of hospitals contains ten public hospitals, two military hospitals and five private hospitals using a panel sample data. The sample period for fifteen hospitals is from 2000/01 to 2004/05 while for two private hospitals are from 2001/02 to 2004/05 leading to a total observation of 83. Due to the existence of different kinds of hospitals, accessibility and availability of adequate data, the sample data is taken from the Addis Ababa City Administration. Both primary and secondary data were employed in the study. Reports and records of each hospital were reviewed and pertinent bodies were interviewed.

To compute the efficiency scores three inputs and three outputs were used. The inputs include salaries of personnel, expenditure on drugs and number of beds while outputs include outpatient visit, inpatient days and number of surgeries. The inputs were selected to represent the whole inputs of a hospital while the outputs were chosen to include the main activities of the hospitals. Description of the outputs and inputs are presented in the following Table.

Table 4.4 outputs and inputs used in the DEA model

Item No.	Variables	Description
	I Outputs	
1	Outpatient visit	New patient equivalent of outpatient visit in the year. Two repeated patients taken as one new patient.
2	Inpatient days	Total length of stay in the year
3	Surgery	Number of both minor and major surgery in the year
	II Inputs	
1	Labor input	Total yearly salary of personnel taken as a proxy
2	Capital input	Number of beds taken as a proxy

3	Drug supplies	Total yearly expenditure on drugs

V EMPIRICAL ANALYSIS

5.1 BASIC CHARACTERSTICS OF HOSPITALS

Among the twelve hospitals, five are central hospitals. Of which, Amanuel, Alert, St.Paulos and St.Peter are owned by the Ministry of Health, while Tikur Anbesa is under Addis Ababa University. Zewditu, Ghandi, Ras Desta, Minilik II and Yekatit 12 are district hospitals, which are owned by Addis Ababa Health Bureau and the remaining two (Armed Force and Federal police) are referral hospitals of the army and police staffs respectively. Following, each hospital is discussed briefly and their basic characteristics are contained in Table 5.1.

Armed Force General Hospital

It is a teaching and referral general hospital. It renders services for the military and civilians serving the Defense and their family member. It delivers a comprehensive general medical

service. Internal Medicine, Pediatrics and Child health and Gynecology and Obstetrics are the main departments in the hospital. During the sampling period, it has been working on yearly average of 612 bed capacity, 339 health personnel and 385 support staff.

Federal Police Hospital

It is a referral general hospital and delivers a comprehensive general medical service. The services are provided to Police personnel and civilians that are working in the police departments as well as their family. In the sampling period, it has been providing the service using yearly average of 252 beds, 190 technical staff and 98 support staff.

St.Peter's TB Specialized Hospital

It was previously known as TB demonstration and Training Centre and the outpatient and inpatient departments had separate administrative bodies for a long period of time. However, based on the assessment done in 2000 it was upgraded to a full service delivery hospital and until now it is the only TB specialized referral hospital in the country. Most of the patients that are served by the hospital are those who are critically ill, coming from the most remote rural areas and the most poor. During the sampling period, it has been rendering services using yearly average of 200 beds, 143 technical staff and 146 support staff.

All Africa Leprosy, Tuberculosis and Rehabilitation Training Centre

It was established in 1934 as a leprosarium by the Sudan Interior Mission (SIM) and named Princes Zenebework memorial hospital. Due to an increase in the magnitude of leprosy and

its impact in Africa, the idea of establishing a leprosy training center was conceived by many international donor agencies. Thus, in 1965 the then Zenebework hospital converted to ALERT (All Africa Leprosy, Rehabilitation and Training Centre).Currently, it is under the ministry of health and the only specialized tertiary referral center for leprosy and dermatology. It is also the only occupational therapy and eye drop production center in the country. In the sampling period, it was serving the public with an average yearly 231 beds, 135 technical and 328 support staffs.

Tikur Anbesa General Specialized Hospital

It was established in 1973 with the name of the Duke of Harar Memorial hospital. In 1974 when the regime changed, Tikur Anbesa hospital emerged after the Duke of Harar hospital merged with Prince Tsehay hospital. It is a general specialized hospital, delivering a comprehensive general medical service and serves as a teaching hospital. Although it is restructured as a tertiary referral hospital, due to poor implementation of the referral system many patients are highly referred to this hospital from all over the country. Officials have argued that if the referral system had been implemented effectively many of the referred patients would be treated either at district hospitals or even at the health center level. In the sampling period, it was serving the public with an average yearly 800 number of beds, 439 technical and 647support staffs

St.Paulos General Specialized Hospital

It was established in 1947 to serve only poor people in the capital city. In 1970, it has established its new building with a capacity of 400 beds. Currently, it is a general specialized hospital and serves as a secondary referral hospital. It supports and serves as a referral hospital for district hospitals, while Tiku Anbesa is a referral hospital of St.Paulos. It provides all kinds of health services except that the pediatrics is given in the outpatient level. In the sampling period, it was serving the public with an average yearly 329 number of beds, 182 technical and 330 support staffs.

St.Amanuel Specialized Hospital

It was established in 1938 as the only psychiatric hospital in Ethiopia. The hospital render the following services: inpatient and outpatient services, medico-legal services, training and supervision of psychiatric nurse, training of medical students, health officers and nurses and mental health research. In the sampling period, it was serving the public with an average yearly 261 number of beds, 63 technical and 238 support staffs.

Zewditu memorial Hospital

It is one of the district hospitals in the city and rendering almost all kinds of health services. In this hospital, all of the health services are provided except eye treatments and pediatrics. In the sampling period, it was serving the public with an average yearly 166 beds, 183 technical and 170 support staffs.

Gandhi memorial Hospital

It is one of the district hospitals in the city and its services are limited to only Gynecology and Obstetrics. Outpatient visit, internal medicine, surgery and other services are provided related with Gynecology and Obstetrics. Among the public hospitals, it is the smallest hospital in bed capacity, number of staff and recurrent expenditure. In the sampling period, it was serving the public with an average yearly 103 beds, 105 technical and 102 support staffs.

Ras Desta Hospital

It is among the district hospitals and well known by its ENT (Ear, Nose, and Tongue) medical treatments. Its services are mainly limited to ENT, eye, internal medicine and surgical treatments. In the sampling period, it was serving the public with an average yearly 120 beds, 73 technical and 117 support staffs.

Minillik II Hospital

It is one of the district hospitals in the city. Even if it is known by its eye treatment services, all the health services are given in the hospital except pediatrics and maternal and child care. It is the only hospital in the country that provides post- mortem examination test. In the sampling period, it was serving the public with an average yearly 263 beds, 210 technical and 206 support staffs.

Yekatit 12 Hospital

It is one of the district hospitals in the city and similar with Zewditu hospital it provides almost all kinds of health services. All health services are provided in this hospital except treatments of eye. Among the public hospitals, (Excluding military hospitals) the pediatrics services are provided only in this hospital and Tiku Anbesa hospital. In the sampling period, it was serving the public with an average yearly 199 beds, 216 technical and 261 support staffs.

Addis Hiwot general Hospital

It was established in 2000 and privately owned. It has not yet started providing health services of maternal and child care. It is the smallest hospital in bed capacity among the private as well as the public hospitals. Similar with other private hospitals, the surgery service is preferred by most patients. In the sampling period, it was serving the public with an average yearly 25 beds, 36 technical and 20 support staffs.

Hayat general Hospital

It was established in 1999 and the largest hospital in bed capacity, number of staffs and recurrent expenditure among the private hospitals. It has recently opened a teaching college. Since the hospital was not established as a teaching hospital, the college is considered as a sister company. In the sampling period, it was serving the public with an average yearly 83 beds, 90 technical and 85 support staffs.

TZNA general Hospital

It was established in 2000 and has been rendering all kinds of health services. Although its number of beds is large, its number of staffs and recurrent expenditure is the lowest among the private hospitals. In the sampling period, it was serving the public with an average yearly 42 beds, 15 technical and 42 support staffs.

Tibebu general Hospital

It was established in 1997 and renders all kinds of health services. It is the second largest hospital in bed capacity and number of staffs next to Hayat hospital. It has been noted that starting from 2004/05 the pediatrics unit has been closed. In the sampling period, it was serving the public with an average yearly 27 beds, 56 technical and 40 support staffs.

Bethel general Hospital

It is the first private teaching hospital in the country. It has started its operation by rendering outpatient services. When it has started the service, the demand was very low due to its long distance from the central city and the absence of residents in the hospital area. In the sampling period, it was serving the public with an average yearly 40 beds, 37 technical and 54 support staffs.

Table 5.1 Basic Characteristics of hospitals and average yearly inputs, 2000/01-2004/05

Hospital	Owner	Year of estab-lishment	Number of Employees			Expenditure ('000 Birr)		Beds
			Physic ian	Tech-nical	Supp-ort	Salary	Drug	
Army	Defense	1956	64	339	385	7,421.10	3,909.32	612
Police	Police	1963	26	190	98	4,423.67	3,187.10	252
St.Peter	Public	1963	18	143	146	2,011.59	823.65	200
ALERT	Public	1934	18	135	328	2,937.97	1,527.54	231
Tikur Anbesa	Public	1973	127	439	647	7,787.73	7,665.74	800
St.Paulos	Public	1947	40	182	330	5,401.56	6,878.49	329
St.Amanuel	Public	1938	16	63	238	2,081.56	2,640.26	261
Zewditu	Public	1970	41	183	170	3,652.87	1,887.06	166
Gandhi	Public	1962	13	105	102	1,851.07	707.56	103
Ras Desta	Public	1932	23	73	117	2,060.30	604.30	120
Minillik II	Public	1909	46	210	206	4,020.52	1,057.02	263

Yekatit	Public	1923	49	216	261	4,010.52	1,262.24	199
Addis Hiwot	Private	2000	19	36	20	670.36	125.27	25
Hayat	Private	1999	26	90	85	3,133.3	1,617.53	83
TZNA	Private	2000	4	15	42	754.18	534.02	42
Tibebu	Private	1997	17	56	40	2,484.28	979.93	27
Bethel	Private	1999	8	37	54	2,506.96	1,077.33	40

Source: Various reports of hospitals and own computation

5.2 Descriptive Analysis

Table 5.2 indicates in the sampling period (2000/01 to 2004/05), the average yearly outputs of the hospitals were: 43,800 outpatient visits, 44,379 inpatient days and 2,388 surgeries while the average yearly salary, number of beds and expenditure on drugs was Birr 3,348,489, 220 and Birr 2,138,383 respectively.

Table 5.2 Means and standard deviations of outputs and inputs of hospitals

Item No.	**Variables**	**Mean**			**Maximum**	
		All	**Public**	**Private**	**Public**	**Private**
	I Outputs					
1	Outpatient visit	43,800	59,960	5,015	149,175	14,220
2	Surgery	2,388	3,165	523	16,147	1,359
3	Inpatient days	44,379	60,523	5,634	197,179	14,152
	II Inputs					
1	Labor input	3,348,489	3,971,678	1,852,837	9,238,542	5,603,852

2	Capital input	220	295	41	800	85
3	Drug supplies	2,138,383	2,679,191	840,445.30	10,536,852.6	2,043,120

When we look at the outputs and inputs share of each hospital, St.Paulos, Tikur Anbesa and Police had the highest inpatient visits in the sampling period while TZNA, Bethel and Addis Hiwot had the lowest. Tikur Anbesa, Police and St.Amanuel were the first three hospitals which had the highest inpatient days while Addis Hiwot, TZNA and Bethel had the lowest. More surgery operation was found at Minilik II, Ras Desta and ALERT while at Addis Hiwot, TZNA and Hayat less surgery operation was found. Regarding the share of inputs, the highest salary and drug expenditure was found at Tikur Anbesa hospital and was also the largest bed size hospital. On the other hand, the lowest salary and drug expenditure was found at Addis Hiwot hospital and also the lowest bed size hospital during the sampling period.

Generally, the public hospitals accounted for 96.6%, 93.6% and 96.3 % of Outpatient Visit, Surgery and Inpatient days respectively while the private hospitals covered only 3.4%, 6.4% and 3.7% respectively. In the case of inputs, public hospitals accounted for 83.7%, 94.6% and 88.4% of Salary, Beds and drugs expenditure respectively while the private hospitals accounted only 16.3%, 5.4% and 11.6% respectively.

5. 3 CRS DEA AND VRS DEA MODELS RESULTS

Technical and scale efficiency scores of each hospital is indicated in Table 5.3.1.In the CRS DEA model among the seventeen hospitals 5 (29.4%) were technically efficient since they

had a relative technical efficiency score of 1(100%).The remaining 12(70.6%) hospitals had a technical efficiency score of less than 1(100%) thereby they were technically inefficient.

When we look at efficiency scores of each hospital, except Police, St.Peter, St.Amanuel, MinillikII and Tibebu the remaining hospitals were found to be technically inefficient. The Overall average technical efficiency score is 0.776(77.6%) with a standard deviation of 25.8%.Out of this, the average technical efficiency score of inefficient hospitals was 0.682(68.2%) with a standard deviation of 25.4%.Among the inefficient hospitals, Addis Hiwot, Hayat and TZNA had a technical efficiency score of less than 50%, Army and Bethel between 51% and 71% and ALERT, Tikur Anbesa, St.Paulos, Zewditu, Gandhi, Ras Desta and Yekatit12 between 75% and 99%.The technical efficiency scores among the inefficient hospitals vary between 0.294(29.4%) in Addis Hiwot hospital to 0.941(94.1%) in Ras Desta hospital.

Table 5.3.1 CRS, VRS and Scale efficiency scores of individual hospitals

Hospital	Ownership	Technical Efficiency		Scale Efficiency	Returns to scale
		CRS	VRS		
Army	Defense	0.510	0.594	0.860	decreasing
Police	Police	1.000	1.000	1.000	constant
St.Peter	Public	1.000	1.000	1.000	constant
ALERT	Public	0.903	0.954	0.946	increasing
Tikur Anbesa	Public	0.892	1.000	0.892	decreasing
St.Paulos	Public	0.909	1.000	0.909	decreasing
St.Amanuel	Public	1.000	1.000	1.000	constant
Zewditu	Public	0.877	0.883	0.993	increasing
Ghandi	Public	0.817	0.920	0.889	increasing
Ras Desta	Public	0.941	1.000	0.941	increasing

Minillik	Public	1.000	1.000	1.000	constant
Yekatit	Public	0.777	0.808	0.962	increasing
Addi Hiwot	Private	0.294	1.000	0.294	increasing
Hayat	Private	0.459	0.562	0.817	increasing
TZNA	Private	0.246	0.944	0.260	increasing
Tibebu	Private	1.000	1.000	1.000	constant
Bethel	Private	0.564	0.844	0.668	increasing

Results of the VRS DEA model (pure technical efficiency score) show that 9(52.9%) hospitals were technically efficient, while the remaining 8(47.1%) hospitals were technically inefficient. Among the inefficient hospitals, Army and Hayat hospitals had a technical efficiency score between 51% and 74% and ALERT,Zewditu,Gandhi,Yekatit12, TZNA and Bethel had a technical efficiency score between 75% and 99%.The average technical efficiency score is 0.912(91.2%) with a standard deviation of 14%.Out of this, the inefficient hospitals had an average technical efficiency score of 0.814(81.4%) with a standard deviation of 15%.This implies that on average they could reduce their utilization of inputs by about 14.6% with out reducing outputs.

The average scale efficiency of the seventeen hospitals were found 0.849(84.9%) with a standard deviation of 23%.Out of this, 5(29.4%) hospitals were scale efficient while the remaining 12 (70.5%) were scale inefficient. Among the scale inefficient hospitals, Addis Hiwot and TZNA hospitals had a scale efficiency score of less than 50%, Bethel between 51% and 74% and Army, ALERT, Tikur Anbesa, St.Paulos, Zewditu, Gandhi, Ras Desta,Yekatit12 and Hayat between 75% and 99%.The average efficiency score of the scale inefficient hospitals was 0.786(78.6%) with a standard deviation of 25% .This means that

they were inefficient due to inappropriate size thereby on average they could reduce their size by 21.4% while leaving their output levels unchanged.

Among the seventeen hospitals, Police, St.Peter, St.Amanuel, MinillikII and Tibebu hospitals exhibited constant returns to scale implying that they were operating at their productive size; Army, Tikur Anbesa and St.Paulos exhibited decreasing returns to scale and ALERT, Zewditu, Gandhi, Ras Desta, Yekatit12, Addis Hiwot, Hayat, TZNA and Bethel exhibited increasing returns to scale. Hospitals exhibited decreasing and increasing returns to scale should scale down and expand respectively both their outputs and inputs in order to operate at their most productive size.

Efficiency scores by ownership type is indicated in Table 5.3.2.Among the nine efficient hospitals, only Addis Hiwot and Tibebu were found to be technically efficient from the private hospitals while the remaining three technically inefficient. Regarding the public hospitals, Police, St.Peter, Tikur Anbesa, St.Paulos, St.Amanuel, MinillikII, and Ras Desta were found to be technically efficient in addition to the previous four public hospitals.

Table5.3.2 Summary of average efficiency scores of public and private hospitals

	Technical efficiency		Scale	Returns to scale		
Hospitals	CRS (%)	VRS (%)	efficiency (%)	CRS (%)	DRS (%)	IRS (%)
All	77.6(25.8)	91.2(14)	84.9(23)	29.4	17.7	52.9
Public	88.6(14)	93(12)	95(5)	23.5	17.7	29.4
Private	51.3(30)	87(18)	60.7(32)	5.9	-	23.5

Note: figure in parenthesis are Standard deviation

Technically inefficient hospitals to be relatively efficient, either they should decrease their excess level of inputs without changing their outputs or increase insufficient level of outputs with out changing their level of inputs. The total and average level of input reduction and output increases are contained in the following Table.

Table 5.3.3 Total and Average input reduction and output increases to make inefficient Hospitals Efficient

Variables	Hospitals by type of ownership				
	All	**Public**		**Private**	
	Total	Total	Mean	Total	Mean
I Outputs					
Outpatient visit	82,983	75,334	18,834	7,650	2,550
Surgery	6,160	6,160	3,080	-	-
Inpatient days	4,798	-	-	4,798	2,400
II Inputs					
Labor input	742,638.42	742,638.42	742,638.40		-
Capital	38	26	13	12	12

input					
Drug supplies	1,382,388.45	724,765.59	241,588.5	657,622.86	219,207.6

If hospitals are concerned with the output side, all the nine inefficient hospitals except Yekatit should increase their level of outpatient visit by 82,983 number, two of them (Central command and Yekatit) should increase their level of surgery by 6,160 number and one hospital that is Bethel should increase its total length of stay by 4,798 days by attracting more admission/inpatient. However, if the hospitals are concerned with the level of inputs, Yekatit12 hospital should decrease its expenditure of salary by 742,638.42 amounts. Where as, all others except Army and Yekatit12, should decrease drug expenditure by 1,382,388.45 amount and three hospitals (Army, ALERT and TZNA) should also decrease their number of beds by 38.

5. 4 DEA-LIKE MALMQUIST MODEL RESULTS

As indicated above this model applies for panel data and calculates indices of total factor productivity (TFP) change, technological change, technical efficiency change and scale efficiency change. However, we used it to obtain technical efficiency change among hospitals in each time period thereby to use the scores as dependent variable in the second stage of the analysis.

Table 5.4.1 indicates the mean efficiency scores of public hospitals are higher than their private counter parts except in period 2004/05.In this period, both public and private hospitals had the same efficiency score. In 2000/01, the mean efficiency score of the private hospitals was found very low due to the absence of Addis Hiwot and TZNA hospitals.

Table 5.4.1 Mean and Standard deviations of efficiency scores of Public and private hospitals

Hospitals	Efficiency Scores of Hospitals				
	2000/01	2001/02	2002/03	2003/04	2004/05
All	0.67(0.36)	0.92(0.16)	0.87(0.17)	0.86(0.19)	0.85(0.20)
Public	0.81(0.22)	0.96(0.08)	0.87(0.17)	0.88(0.19)	0.85(0.20)
Private	0.32(0.42)	0.81(0.25)	0.86(0.21)	0.81(0.22)	0.85(0.20)

Note: figure in parenthesis are Standard deviation

In the sampling period of 2000/01-2004/05, 7(41.2%), 10(58.8%), 7(41.2%),) 8(47.1%) and 7(41.2%), hospitals were found technically efficient.

Table 5.4.2 indicates; in the sampling period only Tikur Anbesa and Minillik are consistently efficient among the public hospitals while Tibebu and Addis Hiwot among the private hospitals. On the other hand, among the public hospitals Army and among the private hospitals Hayat and Bethel were found completely inefficient in the sampling period. In the sampling period, only Police and St.Amanuel were found technically efficient for four years, while Ras Desta was found technically efficient for three years.

Table 5.4.2 Efficiency scores of individual hospitals, 2000/01-2004/05

Hospital	**Ownership**	**Hospital**				
		2000/01	2001/02	2002/03	2003/04	2004/05
Army	Defense	0.718	0.843	0.574	0.520	0.419
Police	Police	0.856	1.000	1.000	1.000	1.000
St.Peter	Public	1.000	1.000	1.000	0.914	0.846
Alert	Public	1.000	1.000	0.755	0.819	0.848
Tikur Anbesa	Public	1.000	1.000	1.000	1.000	1.000
St.Paulos	Public	0.507	1.000	0.663	1.000	0.844
St.Amanuel	Public	1.000	0.911	1.000	1.000	1.000

Zewditu	Public	0.571	0.759	0.999	0.922	1.000
Ghandi	Public	0.609	1.000	0.886	0.862	0.773
Ras Desta	Public	0.500	1.000	0.904	1.000	1.000
Minillik	Public	1.000	1.000	1.000	1.000	1.000
Yekatit	Public	1.000	1.000	0.623	0.480	0.489
Addis Hiwot	Private	-	1.000	1.000	1.000	1.000
Hayat	Private	0.450	0.386	0.537	0.478	0.547
TZNA	Private	-	0.805	1.000	0.710	0.977
Tibebu	Private	1.000	1.000	1.000	1.000	1.000
Bethel	Private	0.132	0.878	0.778	0.886	0.740

5. 5 THE REGRESSION MODEL RESULTS

5. 5.1 INTRODUCTION

The technical efficiency score of hospitals modified to inefficiency score to be influenced by a set of characteristics of hospitals. The inefficiency score is used as a dependent variable and regressed against its determinants of Age, Lsize, Lsize2, Own, Teacstat, Linpddoc, Abor and Docstaf Using a censored Tobit model.

To avoid multicollinearity problem the required test undertaken. The correlation coefficient among the explanatory variables is indicated in Table 5.5.1.

Table 5.5.1 Correlation coefficient among explanatory variables affecting inefficiency scores

	age	*lsize*	*lsize2*	*own*	*techstat*	*linpddoc*	*abor*	*docstat*
age	1.0000							
lsize	0.6215	1.0000						

lsize2	0.5696	0.9940	1.0000					
own	0.8152	0.8375	0.7966	1.0000				
techstat	-0.2368	0.2849	0.3536	-0.0590	1.0000			
linpddoc	0.3960	0.7090	0.6992	0.6603	0.1589	1.0000		
abor	0.1776	0.2250	0.2176	0.2929	-0.1830	0.5854	1.0000	
docstat	-0.2735	-0.4628	-0.4496	-0.4126	-0.2035	-0.5467	-0.2691	1.0000

Table 5.5.1 indicates there is a strong correlation between the variable **own** (type of ownership) and **age** (years of operation) (r=0.8152) and also **own** (type of ownership) and **lsize** (size of a hospital) (r=0.8375).However, the correlation coefficient among other explanatory variables are relatively low. The correlation of the variable **own** with the variables **age** and **lsize** may create a problem on the statistical significance of their estimators.

5.5.2 INTERPRETATION OF THE REGRESSION RESULTS

Table 5.5.2 indicates among the explanatory variables six of them (Age, Lsize, Lsize2, Teacstat, Abor and Docstaf) were found statistically significant while the remaining two (Own and Linpddoc) were insignificant.

Table 5.5.2 summary of the Censored-Tobit regression analysis

Explanatory Variables	Coefficient	Significance [p>/z/]
Constant	-15.72283(-2.74)	0.008

AGE	-0.01469(-1.65)	0.099
LSIZE	7.63295(3.4)	0.001
LSIZE2	-0.74009(-3.37)	0.001
OWN	-0.46533(-0.66)	0.512
TEACSTAT	1.02683(2.08)	0.038
LINPDDOC	-0.11138(-0.54)	0.590
ABOR	-0.00868(-3.40)	0.001
DOCSTAF	-3.33444(-2.00)	0.046
Log likelihood function	-69.149563	

Note: figures in parenthesis are z-values

Age: An examination of this variable result showed that it has a negative relationship with the inefficiency score at 10%. This is due to the fact that as years of operation increases hospitals tend to have more experience to improve their technical efficiency. This implies that a hospital that has more experience is more likely to employ inputs that lead it to achieve the maximum levels of outputs.

Lsize: The coefficient of this variable is positive and significant at 1%. This is due to the fact that, larger hospitals are difficult to be managed than the small ones thereby it has an impact on their efficiency.

Own: It has a negative relationship with the inefficiency scores but highly insignificant (p=0.512). Although researchers came up with different results on ownership and efficiency, all of them have showed that technical efficiency of a firm is influenced by type of ownership. Table 5.5.2 indicates the variable **own** is correlated with the variables **age** and **lsize** .Moreover, the partial correlation estimation of the variable **own** with other explanatory variables shows that it is highly correlated with **Age** and **lsize**.

Table 5.5.3 Partial correlation coefficient of own with other explanatory variables

Variables	*age*	*lsize*	*lsize2*	*techstat*	*linpddoc*	*abor*	*docstat*
Corr.	0.5308	0.3069	-0.2162	-0.1246	0.2127	0.0122	0.0271
Sig.	0.000	0.007	0.059	0.280	0.063	0.916	0.815

For instance, dropping the variable **age** from the first model highly improves both the coefficient and level of significance of the variable **own** (Table 5.5.4).The coefficient of **own** improves from (-0.465) at 60% level of significance to (-1.17) at 5% level of significance. This implies that the impact of ownership was insignificant in our finding was not due to the absence of having any impact on inefficiency but its impact was captured by other variables in the model.

Table 5.5.4 summary of selected Censored-Tobit model regression analysis

	Model1(all variables)		Model2 (excluding age)	
Variables	Coefficient	Sig. [p>/z/]	Coefficient	Sig. [p>/z/]
Constant	-15.72283(-2.74)	0.008	-15.64258(-2.63)	0.008
AGE	-0.01469(-1.65)	0.099	-	
LSIZE	7.63295(3.4)	0.001	7. 37537(3.18)	0.001
LSIZE2	-0.74009(-3.37)	0.001	-0.72283(-3.18)	0.001
OWN	-0.46533(-0.66)	0.512	-1.17455(-1.97)	0.049

TEACSTAT	1.02683(2.08)	0.038	1.21174(2.41)	0.016
LINPDDOC	-0.11138(-0.54)	0.590	-0.03543(-0.17)	0.864
ABOR	-0.00868(-3.40)	0.001	-0.00819(-3.25)	0.001
DOCSTAF	-3.33444(-2.00)	0.046	-3.04463(-1.84)	0.066
Log likelihood function	-69.149563		Log likelihood function	-72.224535

Note: figures in parenthesis are z-values

Teacstat: Teaching status is positively related with inefficiency score and significant at 5% probability level. This result is in line with Campbell's (2001) argument. He argued that as a result of operating difficult case mix, excessive testing and consultation for teaching, they (teaching hospitals) tend to have higher costs and more expensive equipments than non-teaching hospitals.

Linpddoc: The coefficient of the proportion of inpatient treated per medical doctor is negative but statistically highly insignificant. This implies that as the proportion increases, with a given level of inputs (in this case medical doctors) more outputs will be achieved thereby improving efficiency. However, the insignificance of the variable implies that it is a poor proxy for efficiency.

Abor: The proportion of total length of stay (inpatient days) to hospital beds has negative coefficient and statistically highly significant. This result is consistent with Eyob (2000) who showed negative relation ship between bed occupancy and inefficiency.

Docstaf: The proportion of medical doctors to the total staff is negatively related with inefficiency and statistically significant at 5%.The contribution of all staffs of a hospital is indispensable for providing health care services, but our finding showed that the higher the availability of medical doctors in the hospital, the more efficient the hospital will be.

VI SUMMARY AND CONCLUSIONS

DEA has been extensively used to measure technical efficiency of hospitals by different researchers. We applied this method to measure technical efficiency of seventeen hospitals in Addis Ababa City Administration comprising twelve public and five private hospitals using a five year panel data. In this study, CRS DEA, VRS DEA and DEA-Like Malmquist models were analyzed. In order to avoid biases due to extreme observations, the first two models used average figures of the five years data, while the DEA-like Malmquist model was analyzed using the panel data. The efficiency scores obtained from the DEA-Like Malmquist model was used as a dependent variable to regress them against determinants of efficiency.

The CRS DEA model predicted that 70.6% of the hospitals were technically inefficient while the VRS DEA model predicted that 47.1% of the hospitals were technically inefficient

and 70.1% of them were scale inefficient. Among the inefficient hospitals, 25% of them were operating at decreasing returns to scale.

The presence of inefficiencies indicates that the hospitals had either excess inputs or insufficient outputs compared to those efficient hospitals. Therefore, the inefficient hospitals to be technically efficient, they should either increase their outputs level by 82,983 more outpatient visit, 6,160 more surgery and 4,798 more inpatient days while holding input level constant or reduce their inputs by 742,638.42 less salary expenditure, 1,382,388.45 less drug expenditure and 38 less number of beds holding their output constant.

With regard to determinants of technical inefficiency, the Tobit model predicted results of those factors that likely influence the technical inefficiency of hospitals. Among these factors, years of operation, types of ownership, the proportion of inpatient days to the number of medical doctors, average bed occupancy rate and the proportion of medical doctors to the total staff were negatively related with technical inefficiency while hospital size and teaching status were positively related with technical inefficiency.

The result implied that as hospitals stay in operation for long, they tend to be more efficient than the newer hospitals. Moreover, the more an increase in the average bed occupancy rate and the proportion of medical doctors to the total staff is, the more the hospitals tend to be efficient. On the other hand, the larger sized hospitals tend to be less efficient than the smaller sized hospitals and being a teaching hospital more likely to be less efficient than the non-teaching hospitals.

After this, on the basis of theoretical and empirical findings, the following policy implications have been drawn:

The population of Ethiopia experiences poor health status relative to other low income countries and the per capita expenditure on health is also the lowest in Sub-Saharan Africa. Although it has not yet been ratified by the parliament, the government has prepared Health Service Delivery and Management Proclamation and associated regulations to increase resources available for the health sector. Adjusting user fees at government health facilities to increase revenue, using resources efficiently and allowing health facilities to withhold retention from collected fees are some of the issues to be addressed. Therefore, it is advisable for policy makers to assess efficiency of health facilities, particularly hospitals before the document is ratified by the concerned body.

In the process of conducting data collection it was observed that none of the hospitals were using any measurement of efficiency. It is therefore suggested that both the Addis Ababa Health Bureau (AAHB) and the Ministry of Health (MoH) should encourage hospitals to adopt at least simple ratio measures and average bed occupancy rate in order to measure their technical efficiency level. Moreover, it would be of great importance to improve the proper use of the scarce resources if both AAHB and MoH apply DEA model to examine technical efficiency of health facilities at central level in all health facilities in addition to the existing simple ratios they have been used.

The study had revealed excess salary expenditure in the inefficient hospitals and availability of more medical doctors was negatively related to technical inefficiency. It is therefore

suggested that the management of each hospital decrease this excess expenditure by abandoning recruitment of new support staff whenever any support staff either left or retired from the hospital and the savings should be used to improve the remuneration of medical doctors. This remuneration attracts more medical doctors and also motivates them to stay in the hospital than spending time in other health facilities to get additional income.

The national average for percentage of antibiotic and injection (excluding immunization and injectable contraceptives) per counter is 58% and 23% respectively. It is higher compared with the accepted norm of 20% and 15% respectively. Product promotion, cost, availability of drugs and pressure from patients are factors influencing prescribing behavior. Although developing treatment guidelines highly contribute to promote correct prescribing behavior, limiting the number of available drugs, regular supervision and in-service training can also contribute to improve the prescribing habits of physicians(MoH,2002:MoH,2003).It is therefore suggested that reducing excess drug expenditure helps to promote rational use of drugs apart from improving efficiency.

To reduce excess number of beds the management of each hospital will have two alternatives. One, they can transfer them to efficient hospitals (in the case of public hospitals) or sell the beds (in the case of private hospitals).Second, the result has shown that insufficient outputs were found in the inefficient hospitals and also the average bed occupancy rate was negatively related with inefficiency. Therefore, the excess number of beds would be utilized efficiently if the demand for outputs particularly inpatient days are encouraged.

Finally, we did the estimation at micro level in selected hospitals and quality of services and allocative efficiency were not considered due to lack of data. Therefore, by incorporating these variables, future similar studies would be required at national level to compare technical efficiency among all health facilities as well as to identify the level of efficiency savings in the overall health system.

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GLOSSARY

Allocative Efficiency

It refers to both efficiency in production and distribution.

Discharged Patient

The number of patients who are discharged from the health institution (whether it is dead or alive) after being diagnosed and /or treated

District Hospital

It is the first level referral hospital for health center, which provides both outpatient and inpatient services with 50 bed capacity and renders service round the clock for a catchments population of 250,000.

Health Center

The first level health care unit, which provides a package of public health and essential curative services on ambulatory basis to a population of 25,000.

Productive Efficiency

It refers to the production of a given quantity of output with the least cost combination or maximization of output with a given cost

Specialized Hospital

The last referral hospital, which provides medical care for a particular group of population (pediatrics, maternity etc) or a particular disease (Tuberculosis, Leprosy etc) and serves a population of 5 million.

Technical Efficiency

It refers to the physical relation between input resource and output. A firm will attain technical efficiency if it produces its quantity of output with the minimum possible quantities of inputs or if it produces the maximum quantity of output with a given quantities of inputs.

Declaration

I, the undersigned, declare that this thesis is my own original work and has not been presented, in whole or in part, for a degree in any other university. All references used have been dully acknowledged.

Declared by:

Name: _____

Signature: _____

Date: _____

Place: Addis Ababa University, Addis Ababa

This thesis has been submitted for examination with my approval as an MSc. thesis

Supervisor

Name: _____

Signature: _____

Date: _____