PhD Dissertation

Efficiency and Quality Nexus: Evidence from Health Care Facilities in Pakistan

By

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Abstract

The existence of inefficiencies in health care provision is a major health policy concern in the developing countries. Health system of Pakistan mainly constitutes public and private sectors and the private sector covers almost 70 percent of the population. Increasing role of private sector and burden of out of pocket health expenditures highlight the need to investigate the performance of hospitals of private sector. In the first chapter, this study has estimated the technical efficiency of private hospitals of Pakistan for ambulatory services and inpatients care. The data has been used from a survey conducted by Pakistan Bureau of Statistics in 2010-11. Efficiency scores are estimated using Stochastic Frontier Analysis. At second stage, we have explored whether private hospitals in Pakistan increase their efficiency in response to an enhancement in neighboring regions efficiency level. This spatial regression analysis has been done using Spatial Lag Model and Spatial Error Model. We find that efficiency scores of Pakistan's private hospitals are quite low. Not a single hospital is found to be working on full efficiency level. Moreover, the findings of the second stage analysis showed that efficiency has a positive spillover for Outpatient care for small hospitals. Contrary to it, big hospitals have spatial dependence in inpatients care. We concluded that small hospitals compete in outpatients department with the motive of profit maximization, whereas big hospitals compete in inpatients care with the same motive.

In the second chapter, this study has estimated the technical efficiency of public hospitals in Pakistan for obstetric services. The data is taken from the Health Facility Assessment Survey which was conducted by ministry of health, Pakistan in 2010-11. Efficiency scores are estimated using parametric technique Stochastic Frontier Analysis (SFA). The relationship between efficiency and quality is explored using Least Square Dummy Variables (LSDV) and Two-Stage Residual Inclusion (2SRI). The efficiency scores of Pakistan's public hospitals in obstetric services

are found to be quite low. Moreover, the relationship between a hospital's efficiency and the quality of service it provides is found to be positive and statistically significant. We concluded that risk of maternal and neonatal mortality is lower in more efficient hospitals as compared to the less efficient ones. The findings have policy implication that efficiency gains can be achieved without the loss of quality of services provided by the hospitals.

An effective healthcare system can operate properly if it considers patients' perceptions (perceived quality) and modifies itself according to the feedback. The assessment of patients' point of view (perceptions) not only is important to identify the problems in quality assessment, but it will also provide a way forward towards improvement in the existing condition of public healthcare system. In the third chapter, this study has explored the relationship between technical efficiency of health care units (DHQs hospitals), and the patients' perceptions about the quality of services with respect to mother and child health. The data on patient's perceptions' and other control variables are taken from Client Exit Interviews that was part of HFA survey. Three techniques are used to form satisfaction index such as equal weights, Principal Component Analysis and Polychoric Principal Component Analysis for robustness. Two stage residual inclusion, Ordered Logistic Regression and Least square dummy variable techniques are used to investigate the relation between technical efficiency of a hospital and patients satisfaction level. The findings of this chapter reveal negative association exists between efficiency and patients' perceptions which indicates with the increase in hospital efficiency, the satisfaction level of the patients tends to decrease. According to the findings of disaggregated analysis, the patients' level of satisfaction which is associated with the healthcare provider attitude is more affected by the technical efficiency.

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LIST OF ABBREVIATIONS AND ACRONYMS

CCE	Common Correlated Effects
CH	Civil Hospital
CRS	Constant Return to Scale
DEA	Data Envelopment Analysis
DHQ	District Headquarter
DMU	Decision Making Unit
GDP	Gross Domestic Product
HDI	Human Development Index
HFA	Health Facility Assessment
MOH	Ministry of Health
MPI	Multidimensional Poverty Index
NGO	Non-Government Organization
NHA	National Health Accounts
NPO	Non-Profit Organization
OECD	Organization for Economic-Cooperation and Development
OPD	Outpatient Department
PBS	Pakistan Bureau of Statistics
PSLM	Pakistan Social and Living Standard Measurement
RHC	Rural Health Centre
SDPI	Sustainable Development Policy Institute
SFA	Stochastic Frontier Analysis
SPDC	Social Policy Development Centre
THQ	Tehsil Headquarter
TRF	Technical Resource Facility
VRS	Variable Return to Scale
WMO	Women Medical Officer

INTRODUCTION

The existence of inefficiencies in healthcare provision is a major health policy concern. The fundamental goals of policymakers are efficiency and quality in hospital sector. This thesis serves the purpose to investigate the technical efficiency, objective quality (at hospital level) and subjective quality (patients' satisfaction) at patients' level in three chapters. In the first chapter, technical efficiency scores of private hospitals are estimated and spillover effects of technical efficiency has been observed. The technical efficiency scores of the public hospitals are estimated in the second chapter and the relationship between efficiency and objective quality (Mortality rate) is investigated. In the third chapter, the effect of technical efficiency of a hospital on patients' satisfaction level is explored.

In the past few years, healthcare expenditures have been increasing significantly not only in absolute terms but also as a proportion of GDP. To lessen this financial burden, governments in many western countries have initiated pro-competition reforms in the hospital sector. There exists contrasting empirical evidence on the real effects of pro-competition reforms on quality, efficiency and prices of hospitals and it is the most debated issue in the scientific community. The strategic association among the nearby hospitals has substantial importance in the literature of health economics. Some studies conclude that competition leads to better health outcomes (Gaynor, Propper et al. 2016); others claim that increase in competition may worsen peoples' health conditions (Propper, Burgess et al. 2004); whereas others (Mukamel, Zwanziger et al. 2002, Berta, Martini et al. 2016, Colla, Bynum et al. 2016) suggest that there is no relationship between competition and quality.

Pakistan is a developing country and its healthcare system faces many challenges. It has been observed that 66 percent of the total healthcare expenditures are estimated as private, out of which 91 percent are out-of-pocket health expenditures made by households (NHA, 2013-14). The rise in households' out-of-pocket health expenditures is mainly due to increasing role of private sector in the healthcare system of the country. It is very unregulated and fragmented, and hence there is need to explore the performance of the private health sector.

Almost all the private hospitals in Pakistan are working primarily under the motive of profit maximization. Does private hospitals compete to attract more patients to increase their profits? Empirical research is needed to investigate the issue that, whether competition has the effect on the technical efficiency of the private hospitals in Pakistan or not. In the first chapter, this study explores the spillover effects of technical efficiency scores of private hospitals at district level and examine whether hospitals respond to the change in efficiency level of its neighbor or not? Additionally, technical efficiency scores of private hospitals are estimated. The results of the first stage reveal that efficiency level of all the private hospitals are quite low in Pakistan. Spillover effects of technical efficiency are observed for outpatient care in small hospitals and for inpatient care in big hospitals. Different behavior could be observed due to profit motive of the private hospitals.

Increasing role of private sector in the healthcare system in Pakistan could be due to several reasons such as quality of services, facilities provided, performance of the hospitals, and availability of the specialists, doctors etc. Therefore, there is need to study the performance and quality of public hospitals. On the other hand, just focusing on efficiency measurement and ignoring other aspects such as quality of care, may produce misleading results and subsequently wrong policy conclusions. If a trade-off exists between efficiency and quality, then increasing efficiency may lead to deterioration in service quality.

The health status of women and children reflect the level of national health, quality of civil life, and social civilization. Accelerating the development of maternal and child healthcare is of great importance in improving a nation's health quality, promoting economic development and building a harmonious society (Wang, 2016). Health indicators in Pakistan remain very poor, as maternal, neonatal and infant mortality rates are fallen behind other comparable developing countries especially related to mother and child health (CPR, TFR, MMR & PGR etc.)[1] (Bhutta and Hafeez 2015, Pasha, Saleem et al. 2015, Ahmed and Won 2017). Due to slower reduction in these rates, it is reasonable to question the efficiency of healthcare providers, as enhancement in the efficiency may improve mother and child health. This in turn will contribute towards progress of human capital formation (Shaikh 2015). As, Pakistan does not have vast financial resources so they need high efficiency scores of the hospitals to be able to produce more healthcare with less resources. The efficiency analysis of the healthcare units in Pakistan is an unexplored research area which calls for attention, especially by policy makers and research scholars. Hence, it is of utmost importance to conduct an efficiency analysis of the healthcare units that are responsible for mother and child health.

In the second chapter, this study has investigated the technical efficiency of the District and Tehsil Health Quarter hospitals, Civil Hospitals along with rural health centers in the context of maternal, newborn and child health programs. Furthermore, the relationship between the efficiency of above mentioned healthcare providers and the quality of the services provided has also been examined. The analysis reveals that the efficiency scores of Pakistan's public hospitals in obstetric services are quite low. Furthermore, the relationship between a hospital's technical

[1] CPR (Contraceptive prevalence rate) is the proportion of women of reproductive age who are using a contraceptive method. TFR is the total fertility rate, MMR is the maternal mortality rate and PGR is the population growth rate, Jabeen et al., 2011. MMR (Maternal Mortality Rate) is 276 per 100,000 live births and the under-five child mortality rate is around 89 deaths per 1,000 live births

efficiency and the quality of service (Mortality rate) is found to be positive and statistically significant. So, the risk of maternal and neonatal mortality is lower in more efficient hospitals as compared to the less efficient ones. It means that the quality of a hospital can be maintained with efficiency enhancement efforts. In literature, various definitions of quality exist (Mosadeghrad 2014). The concept of healthcare quality is complex, subjective and multidimensional (Parasuraman, Zeithaml et al. 1985, Mosadeghrad 2014).

An effective healthcare system can operate properly if it considers patients' perceptions and modifies itself according to the feedback (Aharony and Strasser 1993). Patients' perceptions are very important in the measurement of overall quality of a healthcare provider (Shaikh 2005). Often, satisfaction is considered as an indicator of patients' perceptions and defined as patient's reaction to healthcare services. Patients then evaluate these services subjectively. Technical efficiency of a hospital, which is the maximization of outcome may have indirect effect on the level of satisfaction of the patients. As, when a hospital aims to increase its efficiency level, it will be more focused on enhanced volume of patients with the given set of resources. Therefore, in effort to increase hospital performance, many other factors such as waiting and consultation time, physician burnout, attitudes of healthcare providers, interpersonal skills (communication between healthcare providers and patients) and physician-patients ratio, may in turn get affected.

In third chapter, this study has examined the relationship between technical efficiency of healthcare units (DHQs hospitals), and the patients' perceptions about the quality of services with respect to mother and child health. The regression findings reveal the negative association exists between efficiency and patients' satisfaction level which indicates with the increase in hospital efficiency, the satisfaction level of the patients tends to decrease. According to the results of disaggregated analysis, the technical efficiency scores of hospitals have significant effect on the satisfaction gain from the attitude of healthcare provider and explanation about the illness as compared to clinical examination and attitude of other staff. This important result shows the preferences of the patients towards their treatments in the hospitals.

This dissertation will contribute in the literature of competition in hospital market, the application of spatial econometrics in health economics and the causal relation between technical efficiency and quality of a hospital in both prospective objective and subjective quality.

Chapter 1

SPATIAL INTERDEPENDENCE OF EFFICIENCY OF PRIVATE HOSPITALS IN PAKISTAN

1.1 INTRODUCTION

The healthcare system of the developing countries like Pakistan is incomparable to developed world due to various challenges which the former face. The most important challenges are the increasing healthcare expenditures in the country. It has been observed that 66 percent of the total healthcare expenditures are estimated as private, out of which 91 percent are out-of-pocket health expenditures made by households (NHA, 2013-14)[2]. The rise in households' out-of-pocket health expenditures is mainly due to increasing role of private sector in the healthcare system of the country. Private sector attends 70 percent of the population in Pakistan (Kumar & Bano, 2017). Almost all the private hospitals in Pakistan are working under the motive of profit maximization. Does private hospitals compete, in the form of efficiency spillovers, to attract more patients for profit maximization in a developing country like Pakistan? To answer this question requires empirical investigation.

This study has examined the existence of strategic interactions among the hospitals at geographical area. Whether the hospitals of one district respond in reaction to increase/decrease in efficiency by their rivals in a competitive environment. In other words, whether the technical efficiencies are strategic complement or substitute. Our analysis follows two-step approach. At first level, the technical efficiency scores are estimated using parametric technique i.e. stochastic

[2] National Health Accounts is an accounting framework which reveals aggregated healthcare expenditures of the country. And it is published by Pakistan Bureau of statistics. Sundmacher, L., et al. (2012)

frontier analysis (SFA) and the second level addresses the spatial interdependence of private healthcare provision at district level for Pakistan.

In the past few years, healthcare expenditures have been increasing significantly not only in absolute term but also as a proportion of GDP (OECD, 2012). To lessen this financial burden, governments in many western countries have initiated pro-competition reforms in the hospital sector. United Kingdom, United States and Netherlands were the first nations to introduce competition in hospital market few years ago. Since then other countries also stated encouraging competition in their hospital market to provide better choice to the patients. There exists contrasting empirical evidence on the real effects of pro-competition reforms on health outcomes. Some studies conclude that competition leads to better health outcomes (Gaynor, Propper, & Seiler, 2016); others claim that increase in competition may worsen the peoples' health conditions (Propper, Burgess, & Green, 2004); whereas others (Berta, Martini, Moscone, & Vittadini, 2016; Colla, Bynum, Austin, & Skinner, 2016; Mukamel, Zwanziger, & Bamezai, 2002) suggest that there is no relationship between competition and quality.

Previously discussed empirical studies assumed that hospitals compete within local market in a pre-specified geographical area to attract more patients. However, according to some studies (Gravelle, Santos, & Siciliani, 2014), hospitals have incentives to compete beyond their geographical boundaries. some empirical studies comprehensively analyze the efficiency, effectiveness and quality of healthcare providers using the data at a geographic/administrative level considering the interdependence of hospitals of different regions (Augurzky & Schmitz, 2010; Felder & Tauchmann, 2009). When the aggregated regional level data is used, the assumption of independent observations used in conventional regression analysis becomes indefensible because the healthcare system in different regions cannot be separated. The scores of the regional efficiency can be biased without the assumption of spatial interdependence due to the patients' mobility across region of the residence as the healthcare services provided to the patients in a region where they reside and also where they don't. According to (Augurzky & Schmitz, 2010) less than 50 percent of total patients are treated within a region of residence in some areas.

The traditional approach was to investigate the effect of competition on efficiency and quality by using market concentration measures like Herfindahl Index. Recently, researchers have started the use of spatial analysis to examine strategic interactions among hospitals (Herwartz & Strumann, 2012; Francesco Longo, Siciliani, Moscelli, & Gravelle, 2017).

According to Herwartz and Strumann (2012), hospitals' negative spatial interdependence show the existence of competition for low cost patients. As, a hospital that is succesful in attracting more patients from its rival show better performance, but this can be other way round especially, when a country has a mixed health care system (public and private) like Pakistan. Therefore, possitive spillover of efficiency can also show existence of competition. At the same time both neighbouring region can be successful in attracting more patients. There can be two potential reasons behind this behaviour, First the presence of unattended patients who are not getting treatment from any hospital. Secondly, Private sector hospitals may be attracting patients from the public sector (e g due to low quality, reputation, provided services etc.), which can also be observed by current expanding role of private sector in Pakistan.

A deep understanding of the performance evaluation and spillover effects of the technical efficiency of private hospitals will be more effective in designing the policies and health interventions. The results of the first stage reveal that efficiency level of all the private hospitals are quite low in Pakistan. Spillover effects of technical efficiency are observed for outpatient care in small hospitals and for inpatient care in big hospitals[3]. Different behavior could be observed due to profit motive of the private hospitals.

Rest of the chapter is organized as follows: the first section presents the detail about the private healthcare system of Pakistan. The comprehensive literature review related to efficiency, application of spatial econometrics and effect of competition on health outcomes is provided in the third section. The fourth section explains data, variables and econometric methodology. Results are discussed in fifth section and last section provides the concluding remarks, some policy suggestions and future research gap.

1.2 PRIVATE HEALTHCARE SYSTEM OF PAKISTAN

Health system of Pakistan mainly constitutes public and private sectors; formal and informal; modern with traditional; faith based healers and NGOs. The private sector covers almost 70 percent of the population and many factors are involved in the low utilization of public sector e g trust, quality, cost, access, gender of the provider etc. (Shaikh, 2015).

1.2.1 Private Healthcare Organization

According to the classification of National Health Accounts (NHA) the healthcare providers are mainly divided into three broad categories in Pakistan; Public Provider, Private Provider and Non-Profit Institutions/ Non-Government Organization (NGO) providers (National Health Accounts, 2009-2010). The private sector has a vital role in the provision of healthcare system in Pakistan. Private hospitals, clinics and other health facilities are widely held in the urban areas and are well equipped and have latest diagnostic facilities. There is more demand for private hospitals than the public healthcare institutes.

[3] Full sample is 749 hospitals which is further divided into two categories according to their sizes. The hospitals having less than fifty number of beds are considered as small hospitals, while big hospitals having number of beds greater than fifty.

The private health sector is composed of a diverse group of doctors, pharmacists, nurses, drug vendors, traditional healers, laboratory technicians, unqualified practitioners and shopkeepers. Most of the private sector hospitals have Partnership and sole proprietorship model of organization. Out-patient care is mainly provided by stand-alone clinics in the private sector and these clinics come under the category of sole proprietorship. The main categories of private sector healthcare providers are:

1. Major hospitals with specialized health facilities
2. Other hospitals with variable quality / level of services
3. Individually owned clinics / general practitioners including dental and eye care. These clinics are either owned by a single person who is the sole proprietor of the facility or they are run on partnership basis.
4. Homeopaths, hakeems, tabibs and other traditional health providers
5. Healthcare facilities from NGOs including the philanthropic organizations
6. Ambulatory health services
7. Facilities providing diagnostic & laboratory services
8. Pharmacies and other retail sellers of medical goods
9. Providers of administration and governance

1.3 LITERATURE REVIEW

The section of literature is divided into three main subsections. The first section provides the detailed literature review related to efficiency measurement. Literature on applications of spatial econometrics is explained in the second subsection and last subsection provides the literature on the effect of competition on the health outcomes.

1.3.1 Efficiency Measurement

Over the past three decades, the efficiency measurement of public and private health organizations is the most explored area of research and many studies have documented that most of healthcare providers do not always utilize the resources efficiently (Carrington, Puthucheary et al. 1997). The efficiency measurement by observing the performance of each unit and comparing it with each other, is a worthwhile tool for vindicating resource allocation, for improvement towards health management and mobilizing inputs. So, the researchers being convinced with this evidence have conducted many studies related to the efficiency measurement of the overall healthcare system in general and hospitals in particular over the previous few years.

Empirical studies regarding the efficiency measurement of the public and private hospitals can be found in literature but these studies are mostly from developed countries. In the US, (Sherman 1984) first estimated the technical efficiency of seven US teaching hospitals by using Data Envelopment Analysis (DEA). After Sherman, many researchers have estimated the technical and allocative efficiency of the US hospitals like (Bannick and Ozcan 1995) have estimated the performance of federally funded hospitals using DEA. Other examples from US (Grosskopf and Valdmanis 1987, Ozcan 1992, Burgess Jr and Wilson 1998, Grosskopf, Margaritis et al. 2004, Ferrier, Rosko et al. 2006).

Until 1994, there have been no studies related to European hospitals. First European study was conducted by Fare et al (1994). He went on to estimate the productivity development in Swedish hospitals using Malmquist output index approach in DEA. Other studies related to European hospitals are (Mobley IV and Magnussen 1998, Athanassopoulos, Gounaris et al. 1999, Sahin and Ozcan 2000, Athanassopoulos and Gounaris 2001) etc. After 1997 a number of studies from other countries including Canada, Kenya, Taiwan, and Turkey have appeared. Examples from UK are (Parkin and Hollingsworth 1997, Maniadakis and Thanassoulis 2000, McCallion, Colin Glass et al. 2000).

The choice of methodologies used to measure efficiency is a controversial issue. In the parametric techniques, there is a variety of production processes which makes it difficult to evaluate efficiency and mostly researchers prefer to use non-parametric techniques (Pina and Torres 1996, Pilyavsky and Staat 2008). There are two widely used methods to measure the technical efficiency of healthcare units: stochastic frontier analysis (SFA), based on regression techniques, and data envelopment analysis (DEA), based on linear programming (O'Neill, Rauner et al. 2008). Every method has its own strengths and weaknesses, but both provide comparable results (Nayar and Ozcan 2008). Data Envelopment Analysis (DEA) is a non-parametric linear programming technique developed by (Charnes, Cooper et al. 1978) based on the ideas of (Farrell 1957). It is non-parametric and hence no assumptions are required on the functional form of the relationship between outputs and inputs. However, it consider the random error as a part of inefficiency. Whereas, SFA allows the possibility of random error as it is stochastic and it is a parametric technique means it requires the functional form (linear, log-linear, Cobb-Douglas, Translog, etc.). One major drawback of SFA is, that it does not allow multiple outputs. This study has used SFA for measurement of technical efficiency due to its strength in separating the random error from inefficiency part. In case of a developing country like Pakistan, the random error cannot be ignored.

1.3.2 Spatial Econometrics

Paelinck and Klaassen (1979) published a book "*Spatial Econometrics*" four decades ago and it is considered as the first attempt to outline the concept of spatial econometrics and related methodologies comprehensively. However, there are some other important publications that appeared in the same year such as "*Exploratory and Explanatory Analysis of Spatial Data",* a book published by (Paelinck and Klaassen 1979) and "*Spatial Time Series"* by (Bennett 1979). Moreover, '*Problems in Estimating Econometric Relations in Space*' was an important article by (Hordijk 1979). So, 1979 is an appropriate reference point for the introduction of term '*spatial econometrics'*.

The concept of Spatial Econometrics evolved over the past forty years. (Paelinck and Klaassen 1979) specified five important principles[4] for the formulation of the spatial models in their book. These principles put emphasis on the significance of spatial variables in econometric models and highlight the difference between conventional time series and spatial series due to spatial interactions. Furthermore, they did not define the term spatial econometrics per *se.* (Anselin 1988) has also concentrated on the specification of the model in regional sciences, although more stress was on specification and estimation testing methods. Comparing spatial and standard econometrics, Anselin (1988) defined the concept of spatial econometrics as, "*the specific spatial aspects of data and models in regional science that preclude a straightforward application of standard econometric methods*". Moreover, it was classified into two main spatial effects; spatial heterogeneity[5] and spatial dependence[6].

Finally, Anselin (2006) removed the context of regional sciences and described spatial econometrics within the toolbox of applied econometrics. Anselin (2006) enhanced the scope of spatial econometrics from cross sectional to space & time domain and explained spatial econometrics as "*a subset of econometric methods that is concerned with spatial aspects present*

[4] (1) spatial interdependence role; (2) the asymmetry in spatial relationships among the observations; (3) the importance of explanatory variables; (4) diversity between *ex post* and *ex ante* relations; and (5) modelling of space (locations) in spatial models.
[5] Spatial heterogeneity means parameters and relationships are not stable across space and vary throughout data sets.
[6] Spatial dependence intimate lack of independence among observations and it means that observations in one region depend on the observations of other regions.

in cross-sectional and space-time observations. Variables related to location, distance and arrangement (topology) are treated explicitly in model specification; estimation; diagnostic checking and prediction".

The move of spatial econometrics field from applied regional and urban economic analysis to the conventional economics and other fields of social sciences is reflected by the way in which the scope and definition of spatial econometrics evolved. The theoretical, methodological and empirical advances in this field during 1970s and 1980s mainly published in journals of geography and regional sciences. Generally, spatial perspective was ignored by econometricians and it was absent in the leading journals of economics and econometrics. Whereas, the situation was different in the case of statistics; attention to spatial perspective dates back to the pioneer work of (Whittle 1954) and then followed by (Besag 1974, Besag and Moran 1975). In recent years, the situation has changed intensely and the attention in this field especially in social sciences has acquired exponential growth (Goodchild, Anselin et al. 2000, Bivand 2008, Anselin 2010, LeSage and Llano 2016).

In early twenty first century, the spatial econometrics as a methodology played a significant role in applied work in environment, epidemiology, crime analysis and public health. (Anselin 2002) highlights the two important factors which are liable for the popularity of spatial econometrics. First, the growing interest in the modeling of the spatial interactions among the heterogeneous observations and secondly, appropriate techniques are required to handle available spatial data. Therefore, the applied researchers have acknowledged that spatial (neighborhood) effects play crucial role in the econometric analysis. (Burchardi and Hassan 2013) explored that social ties have long term effects on regional and individual economic prosperity (Durlauf 2004, Knies, Burgess et al. 2008).

The researchers in health economics were gradually attracted by the application of spatial econometrics due to the significance of analyzing the effect of interdependence of institutional and geographical factors on all kind of variables of neighboring observations such as healthcare providers and hospitals (Moscone and Tosetti, 2014).

Most of the current literature put emphasis on spillover effects of healthcare expenditures on neighboring regions (Eibich and Ziebarth 2014) and also on the indicators of quality provided by healthcare suppliers (Gravelle, Santos et al. 2014). The literature of spatial econometrics in health economics is fragmented and divided into many subfields such as public health and epidemiological literature focuses on the spatial variations in healthcare or health expenditures and their determinants (Michimi and Wimberly 2010, Voigtländer, Berger et al. 2010, Sundmacher, Gaskins et al. 2012, Frakes 2013, Eibich and Ziebarth 2014). Some other empirical studies explore the regional effects or spillover effects of healthcare utilization in spatial analysis and explicitly model the spatial interdependence (Andersen, Bech et al. 2012, Barufi, Haddad et al. 2012, Hajizadeh, Campbell et al. 2012, Filippini, Ortiz et al. 2013, Ortiz and Masiero 2013, Eibich and Ziebarth 2014). Dartmouth Atlas of Healthcare (2013) provides detailed geographical information for US on how the healthcare utilization, expenditures and infrastructure differ at county level. According to (Wennberg, Fisher et al. 2003) better health outcomes with limited expenditures can be achieved by understanding the factors behind regional differences and measures of health expenditures and utilization have no association with better health outcomes.

Multilevel models are used by many studies to explore the relation between measures of health expenditures and their determinants. However, (Riva, Gauvin et al. 2007) highlights that most of the studies ignore the spatial dependency between the regions and measures correlation within area. So, it means that these studies make implicit assumption that the geographical locations are statistically independent.

Moscone and Tosetti (2010) evaluates the association between health expenditures and income with CCE (Common Correlated Effects) method, whereas (Moscone, Knapp et al. 2007) analyze cross-municipality disparities in mental health expenditures by using same approach. (Felder and Tauchmann 2013) combine parametric and non-parametric regressions for efficiency analysis of healthcare providers at regional level in Germany and account spatial dependence using spatial autoregressive models. (Bech and Lauridsen 2009) use SUR model to measure the relation between health expenditures and healthcare supply in Denmark as well as zonal characteristics and account for regional dependence using spatial autoregressive model. Several studies applied spatial econometrics on panel data in health economics such as (Cohen, Osleeb et al. 2013, Lagravinese, Moscone et al. 2014).

1.3.3 The effect of competition on hospital outcomes

The effect of prospective interaction among healthcare providers in different aspects attracts the attention of health researchers progressively. Therefore, it means that the neighboring hospitals may not have indifferent behavior. To investigate underlying notion, (Mobley, Frech Iii et al. 2009) measure reaction functions of price determination for the hospitals of US, where prices were not static and use spatial autoregressive model to investigate the strategic complementarity of prices. The theoretical and empirical literature of the impact of competition on quality of services provided by hospitals suggests that hospitals are tempted to compete with their rivals for maintaining quality under regulated price level within the local market (Brekke, Siciliani et al. 2011). In this perspective, (Gravelle, Santos et al. 2014) explored that most of the healthcare providers are strategic complements in quality dimensions in UK and (Guccio and Lisi 2016) found significant peer effects in Italy and investigate the effected behavior of the hospitals by their peers.

Theory of hospital competition depends on whether hospitals compete on quality or prices. The private hospitals usually have profit-seeking behavior which grounds many challenges as noted in various parts of the world. For instance, in France, private hospitals offer the most expensive treatment. According to the experiences of Colombia and Brazil, access to private hospitals is limited because the services provided by them are very costly. To conclude, increased competition in for-profit hospitals may lead to enhance quality and efficiency rather effecting only prices. More precisely prices are not only the function of competition; there are some other factors which may be the important part of price reaction function of a hospital. For example, local market density, competitor or its own reputation, demand characteristics, other sources of income for living of his households and his own preferences (Choné, Coudin et al. 2014).

Economic theory and empirical evidence both support the benefits of initializing competition in hospital market. Cooper and Gaynor explain the potential effects of competition on quality and prices in the report of OECD (2012). According to this study, if the prices are higher than marginal cost then quality of health outcomes increases with the increase in competition under regulated prices. Whereas the overall effects of competition are uncertain if prices are market determined (OECD, 2012).

The strategic association among nearby hospitals has substantial importance in the literature of health economics, such as hospital mergers and their effect on hospital related variables. Brekke et al. (2015) developed a theoretical model on merging of hospitals and its effect on efficiency and quality. Furthermore, this study shows that the merging of hospitals may result in reduction of quality indicators and if the qualities are strategic complements then merging may reduce the quality of non-merging healthcare providers. Whereas, they find that merging will increase efficiency and if efficiencies are complements then non-merging hospitals will also increase efficiency levels.

Several studies have investigated the effects of hospital competition on the quality, equity and efficiency indicators of healthcare providers after the implementation of pro-competition reforms in health area. These reforms were implemented by the central and local governments of Western countries in early twenty first century with the view that the competition among the healthcare providers would lead to better health outcomes under regulated price level. Some studies verify this hypothesis and concluded that competition leads to better health outcomes (Gaynor, Propper et al. 2016). Whereas others contend that the health status of the people may deteriorate with more competition (Propper, Burgess et al. 2004) and some others show no relationship between more competition and quality (Berta, Martini et al. 2016, Colla, Bynum et al. 2016).

Healthcare services are mainly provided by hospitals and they should utilize their resources efficiently. Quality and efficiency of healthcare provision in hospitals are important objectives in policy making and competition induces the providers to compete on efficiency in the presence of fixed prices to attract patients (Gaynor 2007, Longo, Siciliani et al. 2017). Several empirical studies investigated the effects of competition on various health outcomes with contrasting results for US, UK and OECD countries. Conventionally, market concentration measures (e.g. Herfindahl Index) using the quality and efficiency indicators were used as a proxy of competition and at second stage the effect of competition on quality and efficiency scores of healthcare providers was examined. Recently, researchers in health economics use spatial econometrics techniques to investigate the spillover effects of efficiency and quality indicators.

The above stated studies make one common assumption that the hospitals compete with their rivals within their catchment area[7] to attract more patients. However, hospitals are induced to compete beyond their local market and this kind of global competition among the hospitals may arise in an extremely competitive environment. Especially hospitals compete in quality globally to attract patients (Gravelle, Santos et al. 2014, Lisi, Moscone et al. 2017, Longo, Siciliani et al. 2017). Furthermore, spatial patterns in the efficiency level of hospitals have received less attention of the researcher of health economics so far. However, a few studies have analyzed existence of spatial interactions in hospital efficiency.

According to (Longo, Siciliani et al. 2017), due to common institutional and geographical factors and strategic interactions, the efficiency of a hospital might be affected by the efficiency of nearby hospitals. Moreover, this study has examined the spatial interdependence of efficiency of hospitals in UK using spatial models (SAR and SAC) for cross-sectional and panel data on many efficiency indicators such as cost indices and bed occupancy rate. So, their findings do not support the presence of spatial patterns in efficiency. (Brekke, Siciliani et al. 2015) explains the importance of investigation of spatial interaction of efficiency among hospitals in policy point of view and this evaluation may be helpful to estimate prospective implications of antitrust policies and merging of hospitals.

Herwartz and Strumann (2012) has employed two stage techniques, where at first stage the efficiency score of the healthcare providers is estimated using non-parametric technique such as Data Envelopment Analysis (DEA) and also parametric technique such as Stochastic Frontier Analysis (SFA). At second stage Spatial Autoregressive Models are employed to examine the existence of spatial effects among hospitals and finally, conclude that with the increase in

[7] It is a predefined geographical region around hospitals.

competition for low cost patients has tempted a negative spillover effects in hospital efficiency score after the implementation of potential hospital reimbursement in Germany.

Several empirical studies conduct the above stated analysis using the data at hospital level (Herwartz and Strumann 2012, Longo, Siciliani et al. 2017). However, the prospective sources of inefficiencies are hard to address using the data at the level of healthcare providers because these sources i.e. poor coordination between inpatients and outpatients, redundant medical treatment and overutilization of services mainly occurred due to lack of exchanged information. Some recent studies have done this analysis using the regional level data taking into account the spatial interdependence for Germany (Augurzky and Schmitz 2010, Felder and Tauchmann 2013). At regional level data, the conventional assumption of independent observations cannot be held because the healthcare system cannot be parted regionally. Patients received healthcare services in the district where they reside and also where they don't. This flow fully account for both inputs (e.g. doctors, specialists, nurses, other staff) and outputs (outpatients and inpatients). (Augurzky and Schmitz 2010) explain in detail the flows of hospital sector and find that less than 50 percent patients are treated within the boundaries of a district.

According to (Felder and Tauchmann 2013), spatial dependence increases the effect of states on the efficiency scores and less efficient districts are more affected by positive spillovers of efficiency. At regional level, the positive spillovers are mainly due to patients' migration and competition and these issues have been analyzed by using spatial autoregressive model for the districts of Germany. Therefore, the analysis of efficiency of healthcare system at district level without considering spatial interdependence can provide misleading results at both levels. Firstly the efficiency scores may be biased due to flows of inpatients and outpatients and secondly the results of determinants may provide misleading empirical evidence.

Regional health inequality has become the most debated issue in public discussion and differences in the efficiencies of health provision at state level have also attracted the interest of researchers. Several empirical researchers find these differences in their studies (Augurzky and Schmitz 2010). The current study is also concerned with analyzing this issue taking into account the spatial dependence.

Our analysis follows two-step approach. At first level, the technical efficiency scores are estimated using parametric technique i.e. stochastic frontier analysis (SFA) and the second level addresses the spatial interdependence of private healthcare provision at district level for Pakistan.

1.4 DATA, VARIABLES AND ECONOMETRIC METHODOLOGY

This section contains details about data, variables and econometric methodology. The theoretical methodology is discussed in first sub section and empirical specifications are presented in second subsection. The last section is on data and variables used in the study.

1.4.1 Spatial economic analysis

In Geography an important concept is that neighboring localities share similar properties than the distant areas and this is known as the 'Tobler's first law of geography' "Everything is related to everything else, but near things are more related than distant things" (Tobler 1970). Conventional/classical econometrics/regression analysis is unsuccessful in incorporating spatial effects such as spatial independence, spatial autocorrelation and identification of spatial outliers (Franzese, Hays et al. 2016). Conventional regression analysis commonly assumes the independence of observations/locations over space but it is an unrealistic assumption. So the results will be biased and inconsistent. The analytical techniques of spatial econometrics identify nearest neighbors and include dependence among observations/regions over space (Anselin 1992).

There are two main types of spatial effects such as spatial heterogeneity and spatial dependence. Spatial heterogeneity means parameters and relationships are not stable across space and vary throughout data-sets. On the other hand, spatial dependence intimate lack of independence among observations and it means that observations in one region depend on the observations of other regions. Non-stationarity is an extremely unrealistic assumption if the variables under consideration belong to different regions across space. Moreover, spatial autocorrelation violates the assumption of independence. Therefore classical regression analysis can produce biased results devoid of compensating spatial dependency. So spatial analysis techniques have been developed to analyze and measure the spatial dependency.

The quantification of all the aspects of the locational data is very important to answer all the questions related to heterogeneity and spatial dependence. The first source of locational information is latitude & longitude and distances can be calculated in space from this source of information. Distance among the observations matter for both spatial dependence and heterogeneity point of view. This suggests that the near observations should have greater spatial dependence as compared to distant one. Distance is also very important for the heterogeneity of the relationships. As the nearby observations should have the similar relationship and distant may reveal dissimilar.

Whereas contiguity is the second source of information and it reflects the relative position of one observation in space to the other. The neighboring observations should have greater spatial dependence and regarding spatial heterogeneity, relationship might be similar for nearby observations. Consider that these two kinds of locational information are not essentially different. As contiguity structure can be constructed given the coordinates of a unit by defining the neighbors which lies within a defined distance (LeSage and Llano 2016).

Boundary edge or point of a unit can be used to define the neighborhood or contiguity and (Lesage 1999) defined contiguity in several ways; Linear contiguity (When a unit share an edge or border with the immediate neighbor); Rook contiguity (When units share common side); Bishop contiguity (when units share a vertex); Double linear contiguity (When a county share edge to immediate left or right); Double rook contiguity (when a county share edge to immediate east, west, north and south of the neighbor) and Queen contiguity (When unit share a vertex or common side).

Sometimes double linear and double rook referred to as second order contiguity and whereas other four definitions are termed as first order contiguity. This spatial relationship among the observations is summarized by the spatial weight matrix and it provides the information about how the units are related to each other. The observation at one point in space can be related to the other observations in the system due to spatial weight matrix. It is expressed as **W** with elements w_{ij}showing the relation of observations i and j. The spatial weight matrix **W** is defined as:

$$W = \begin{bmatrix} w_{11} & w_{12} & \dots\dots\dots\dots & w_{1n} \\ w_{21} & w_{22} & \dots\dots\dots\dots & w_{2n} \\ \dots\dots\dots\dots & \dots\dots\dots\dots & \dots\dots\dots\dots & \dots \\ \dots\dots\dots\dots & \dots\dots\dots\dots & \dots\dots\dots\dots & \dots \\ \dots\dots\dots\dots & \dots\dots\dots\dots & \dots\dots\dots\dots & \dots \\ w_{n1} & w_{n2} & \dots\dots\dots\dots & w_{nn} \end{bmatrix}$$

The diagonal elements of weight matrix $w_{11}, w_{22}, \dots, w_{nn}$ are equal to zero, it means 'self-influence' is excluded and non-diagonal are non-zero for the spatial units that are related to each other and zero for distant units. The dimension of the weight matrix is (n×n) for n spatial observations and it should be "row standardized", which means sum of each row should be equal to one. There are two main types of spatial weight matrices. One is based on distance and the other is on contiguity.

1.4.1.1 Spatial Weight Matrix based on Contiguity

The spatial units will be considered as neighbor if a unit i shares a vertex or edge with other unit j and it will take the value one or else zero. The diagonal elements of this matrix are also zero indicating that a unit can't be a neighbor of itself. It is a symmetric matrix and it tells us the effect of contiguous neighbors on each other.

$$W_{ij} = \begin{cases} 1 & if \;\; i \; is \; contiguous \; to \; j \\ 0 & otherwise \end{cases}$$

After the row standardization, the spatial value of each variable is measured as the weighted average of the adjacent units as:

$$y_i = \sum_j w_{ij} y_j$$

Where w_{ij} is the spatial weight and its sum should be equal to one in weighted average formulae.

1.4.1.2 Spatial weight matrix based on distance

This weight matrix based on the average distance from one spatial unit to other and locational information (longitude and latitude) is needed to measure that distance among observations. In this type of matrix, the distance is calculated from the centroids of the units. Assume d_{ij} is the distance between the spatial units i and j. Let D be the distance band outside which the spatial effect is zero.

$$W_{ij} = \begin{cases} 1 & if \; the \; distance \; between \; i \; and \; j < D \\ 0 & otherwise \end{cases}$$

The spatial weights of the neighbors (lies within a specified radius) will be one and else zero. There is an alternative specification of the spatial weight matrix based on distance where the spatial units within a specified distance d_{ij} obtain a weight which is inversely proportional to the distance among units and receive zero weight beyond the specified band D.

$$W_{ij} = \begin{cases} 1/d_{ij} & if\ the\ distance\ between\ i\ and\ j < D \\ 0 & otherwise \end{cases}$$

The spatial regression results will be equal to OLS regression results if the distance band D goes to zero and if it goes to the maximum distance then all the spatial units will have at least one neighbor.

1.4.1.3 Measures of Spatial Autocorrelation

The global Moran's I test exhibits the data's spatial association in space and calculate similarities and dissimilarities among spatial units over space (Anselin 1992). It measures the spatial autocorrelation in the residuals of the spatial regression and it checks the similarities among the variables of different units under study in the spatial weight matrix (Bowen et al., 2001). Spatial autocorrelation[8] takes place when the spatial distribution reveals a regular pattern and positive or negative spatial correlation occurs when neighbors in geographical areas contain similar or dissimilar values of the variables under study (Cliff and Ord 1981). If the value of Moran's I stat is greater than critical value then the null hypothesis (no autocorrelation) is rejected (Anselin 2010).

Moran's I is defined as:

$$I = (N/S_o)\left(\frac{\sum_i^n \sum_j^n w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_i^n (y_i - \bar{y})^2}\right)$$

Where y_i is the unit of observation at location i , $\bar{y}$ is the average of observations from all the locations, n is total number of geographical locations, w_{ij} represents an elements of spatial weight matrix and it shows the relationship of the variables under study between location i and j.

[8] Other measures of global autocorrelation Geary's C statistics and Getis and Ord's G statistic, for details see (Anselin, 1995).

Where $S_o = \sum_i \sum_j w_{ij}$ is a scaling factor that relates to the sum of all the terms of spatial weight matrix and $S_o = N$ for row standardization and each row of the weight matrix is summed to one. Then the first term in Moran's I equation will be equal to 1 and Moran's I simplifies to:

$$I = \frac{\sum_i^n \sum_j^n w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_i^n (y_i - \bar{y})^2}$$

The theoretical mean of Moran's I is:

$$E(I) = -1/(n-1)$$

The expected value of the Moran's I is only the function of sample size (n), therefore with the increase in sample size, the expected value will tend to zero. The value of Moran's I ranges from -1 to +1. The value +1 indicate perfect spatial correlation, -1 point towards perfect spatial dispersion and 0 shows random spatial pattern. When the calculated value of Moran's I is greater than its expected value, then the distribution of dependent variable will exhibit positive spatial autocorrelation. It implies that the value of variable under study is similar at all the spatial locations. Whereas, if its value is less than the expected value, then the distribution will be categorized by negative spatial autocorrelation which implies that the value of the dependent variable will be different at each contiguous location. Inferences are based on z values and it is computed as:

$$Z = \frac{I - E(I)}{sd(I)}$$

Where $E(I)$ is the expected value of Moran's I and $sd(I)$ is its standard deviation. The variance or standard deviation of the Moran's I depends on some assumptions[9] and these

[9] The two most common assumptions are Normality (all the variables under study should have normal distribution) and randomization assumption (each observed value have equal chance to occur at all spatial locations) and for details

assumptions are related to the nature of spatial autocorrelation and data. Under the assumption of randomization the z-statistics asymptotically follows the normal distribution. A significant and positive value of z-stats for Moran's I with low p-value indicates positive spatial autocorrelation and vice versa (Anselin 1988).

1.4.1.4 Spatial Auto-Regressive Models

Spatial autoregressive models are also known as spatial lag models and these models allow incorporating dependence among the observations, which arises when the observations belong to different locations in the space (LeSage and Llano 2016). The complete treatment of these models by using maximum likelihood method is explained by Anselin (1988). A spatial autoregressive model in most general form is given as:

$$y = \rho W_1 y + X\beta + u$$

$$u = \lambda W_2 u + \varepsilon$$

$$\varepsilon \sim N(0, \sigma^2 I_n)$$

Where y contains the vector of dependent variables, X is the matrix of control variables, W_1 and W_2 represent weight matrices, which contains distance or contiguity relations among observations over space.

Total variations in y are explained by neighboring observations without any control variables in this model. By assuming $W_1 = 0$ in the general model, a model with spatial autocorrelation can be derived:

$$y = X\beta + u$$

of the later assumption, see Sokal, R. R., et al. (1998). "Local spatial autocorrelation in a biological model." Geographical Analysis **30**(4): 331-354.

$$u = \lambda W_2 u + \varepsilon$$

$$\varepsilon \sim N\,(0, \sigma^2 I_n)$$

If spatial lag of the control variables matrix X is added along with the spatial lag of the dependent variables matrix in the equation, a model is derived that is known as spatial Durban model:

$$y = \rho W_1 y + X\beta_1 + W_1 X \beta_2 + u$$

$$\varepsilon \sim N\,(0, \sigma^2 I_n)$$

By imposing restrictions in general model, specific models can be derived such as $W_2 = 0 \; and \; X = 0$. Now it is reduced to first order spatial autoregressive model (FAR):

$$y = \rho W y + u$$

$$\varepsilon \sim N\,(0, \sigma^2 I_n)$$

Where the weight matrix W is row standardized (sum of each row is equal to 1) and the vector of dependent variables y is expressed as the deviations from the mean value. By applying least square to the FAR model, an estimate for the dependence parameter is:

$$\hat{\rho} = (y'W'Wy)^{-1} y'W'y$$

Is this an unbiased estimate or consistent? To answer these questions, substitute the value of y to show $E(\hat{\rho}) = \rho$ following the least square approach:

$$E(\hat{\rho}) = E[(y'W'Wy)^{-1} y'W'(\rho W y + u)]$$

$$= \rho + E[(y'W'Wy)^{-1} y'W'u]$$

The estimates are biased as $E(\hat{\rho}) \neq \rho$. The independent variables matrix is fixed in conventional regression and $E(u) = 0$, eliminating the biased term. However, Wy is not fixed for all observations in case of spatial dependence and probability limit of the term $y'W'u$ is not zero, so it also rule out consistency (Anselin 1988).

Hence, least squares yield biased and inconsistent results of the spatial parameter ρ, so Maximum Likelihood approach is used to estimate parameter ρ which requires a value of ρ that maximizes the Likelihood function, the Maximization problem is:

$$L(y/\rho\,,\sigma^2) = \frac{1}{2\pi\sigma^{2(n/2)}}|I_n - \rho W| \exp\{-\frac{1}{2\sigma^2}(y-\rho Wy)'(y-\rho Wy)\}$$

$$and \qquad \hat{\sigma}^2 = \left(\frac{1}{n}\right)(y-\rho Wy)'(y-\rho Wy)$$

For simplifying the maximization problem substitute value of $\hat{\sigma}^2$ in the likelihood function and obtain the expression by taking logarithm:

$$Ln(L) = -\frac{n}{2}\ln(\pi) - \frac{n}{2}\ln(y-\rho Wy)'(y-\rho Wy) + \ln|I_n - \rho W|$$

This equation can be maximized by using univariate optimization with respect to ρ and the estimates of σ^2 can be achieved by using the maximum likelihood value of ρ which is expressed as:

$$\hat{\sigma}^2 = \left(\frac{1}{n}\right)(y-\tilde{\rho}Wy)'(y-\tilde{\rho}Wy)$$

According to (Anselin, Bera et al. 1996) , the feasible range for the spatial parameter ρ is:

$$1/\lambda_{min} < \rho < 1/\lambda_{max}$$

Where λ_{min} is the minimum eigenvalue of standardized weight matrix and λ_{max} is its maximum eigenvalue.

1.4.2 Empirical Specifications

This section is divided into two main parts. The first section contain the empirical specifications for technical efficiency measurement. The specification of the spatial models are provided in the second section.

1.4.2.1 Efficiency Measurement

Efficiency is measured by examining the relationship between output (product of the healthcare system) and inputs (the resources used to produce that output). The Stochastic Production Frontier of Cobb Douglas form is given below;

$$lny_i = \alpha + ln(x_i')\beta_i + v_i - \mu_i$$

Where y_i represent the output of i[th] hospital, x_i' is the vector of inputs of i[th] hospital and $\beta_i$represent the vector of parameters. $v_i,\ \mu_i$ are two parts of error term with the following assumptions,

i. $v_i \sim iidN(0, \sigma_v^2)$
ii. μ_i with exponential distribution
iii. μ_i and v_i are independently distributed with each other and also with the regressor.

The symmetric error term v_i is the usual error term to allow for random factors like measurement errors, weather, strikes etc. The non-negative error term μ_i is the inefficiency component. Subscript i stand for i[th] hospital.

1.4.2.2 Spatial Analysis

To investigate whether the aggregated efficiency of the hospitals of a district is strategic complement or substitute of its rival's efficiency, we use the following relation,

$$E_i = f\left(E_j, X_i, \varepsilon_i\right) \qquad i = (1, \dots \dots, I)$$

Where E_i is the efficiency score of district i; E_j is the efficiency of district j;X_i is the vector of control variables at district level (health, education, population) and ε_i is random error. Global Moran's I test is used to check the existence of spatial dependence of efficiency scores among the private hospitals of different districts of Pakistan. Then, we estimate spatial cross-sectional lag and error models after controlling for the observable covariates.

The spatial cross-sectional lag and error models are as follows;

$$E_i = \rho \sum_j w_{ij} E_j + \beta' X_i + \varepsilon_i$$

And

$$E_i = \beta' X_i + \varepsilon_i$$

$$\varepsilon_i = \lambda w_{ij} + \epsilon_i$$

Where E_j is the average efficiency of all hospitals in district j which is rival of average efficiency of hospitals in district i and w_{ij} is the weight matrix associated with the spatial interaction among hospitals. X_i contains the intercepts and ε_i is random error. The previous equation can be rewritten in matrix form,

$$E = \rho W E + X\beta + \varepsilon$$

And

$$E = X\beta + \varepsilon$$

$$\varepsilon = \lambda W + \epsilon$$

Where W is the weight matrix composed of $w_{ij}$and spatial weights are generated by the inverse distance function.

$$w_{ij} = \begin{cases} 0 & if\ i = j \\ d_{ij}^{-1} & if\ d_{ij} \leq 111km\ and\ i \neq j \\ 0 & if\ d_{ij} > 111km\ and\ i \neq j \end{cases}$$

Where d_{ij} is the distance between two districts and here it is assumed that 111 km is the radius in which the hospitals of a district compete. Districts that are within 111 km radius are assigned weights and those that are further than 111 km radius given zero weights. WE is weighted average of efficiency of neighboring district and the weight matrix W is row standardized meaning that sum of all the elements of each row equal to one. ρ is a key coefficient and it confirms the existence of spatial autocorrelation when it is strictly positive and significant. The spatial correlation among the hospitals of different districts can exist due to strategic interaction but other reasons can also be there. Firstly, the hospitals of neighbor districts may share common unobserved characteristics which affect the efficiency of hospitals in that given area. For instance, the neighboring hospitals are likely to provide high quality services and employ skilled doctors and other staff to improve efficiency and quality. Second, the efficiency of a hospital may vary with the observed or unobserved characteristics of neighboring districts.

1.4.3 Data and Variables

Our empirical analysis follows two steps. Data is taken from Pakistan Bureau of Statistic (PBS) for the performance evaluation of the private sector hospitals at first level. PBS used mixed strategy approach for the census and survey in the year 2010-2011. Small healthcare providers (number of beds < 50) are covered under the survey. Whereas, the census approach was used to cover big hospitals (number of beds > 50). They developed separate questionnaires for both census and survey. They have developed the frame for census by gathering information from regional offices of PBS, Economic Census 2005, websites of hospitals and desk review.

All the functioning hospitals in 2009-2010 were covered in census and survey. The information was collected from the hospitals by the regional offices of PBS in their field jurisdiction and the information was gathered for two time periods 2007-2008 and 2009-2010. Following the literature, this study has used two outputs, inpatients and outpatients pertaining to hospital performance and five inputs including general practitioner doctors, specialist doctors, paramedical staff, other staff and number of beds. These variables are widely used in the literature for the efficiency measurement of hospitals (Navarro-Espigares and Torres 2011) as a representative of productive factors, human resource and capital. Inpatients and outpatients are most widely used measures of outcome in hospital efficiency studies (Valdmanis, Rosko et al. 2008). Efficiency measurement is all about the efficient resource utilization and it has been explored that doctors are accountable for 80% of hospital's resource utilization (Chilingerian and Sherman 1997). Hence, the physicians (general practitioner doctors and specialist doctors) and paramedical staff are selected as a measure of human resource (labor). Moreover, number of beds is taken as a measure of capital. The district[10] level data is taken from different sources. There are total 156 districts in Pakistan according to 2017 Census but at the time of the survey, there were 141 districts. This analysis is based on 80 districts due to data constraints. The district level data on very important variables is not available officially. Therefore, data on some variable i.e. HDI (Human Development Index) and MPI (Multidimensional Poverty Index) (Naveed and Ali 2012) are developed by researchers[11]

[10] After provinces and divisions, districts are the third order administrative division of Pakistan. According to census of 2017, there are 156 total districts in Pakistan. Baluchistan contain 32 districts, Punjab has 36, KPK covers 25 and Sindh comprises 29. Whereas, Azad Jammu and Kashmir and Gilgit-Baltistan hold 10, 10 districts, Islamabad 1 and Tribal areas 13.

[11] Haroon Jamal from SPDC (Social Policy Development Centre) and Arif Naveed from SDPI (Sustainable Development Policy Institute).

and organizations. The descriptive statistics of all the variables included in the analysis are explained in the following table.

Table 1.1 Descriptive Statistics of Variables

	N	Mean	Std. Deviation	Minimum	Maximum
Efficiency Indicator					
Outputs					
Inpatients	749	1,800	6,809	1	144,497
Outpatients	749	17,132	52,637	1	967,994
Inputs					
No of beds	749	34.49	78.66	2	747
Doctors	749	7.348	23.55	1	323
Specialists	749	6.742	15.96	1	200
Paramedical Staff	749	26.13	104.5	1	1,744
Other Staff	749	27.94	200.2	1	4,564
Control Variables					
Prenatal Care	80	64.42	13.92	32	94
Immunization	80	78.24	16.73	20	99
MPI	80	0.155	0.0835	0.02	0.422
Density	80	1,239	7,724	0.400	69,341

Note: Control variables are on district level.

Two variables prenatal care and immunization are taken as proxy for health, population density is used as demographic information and MPI is used as poverty indicator. Prenatal care is preventive healthcare and it refers to regular checkup of pregnant women before the child birth. The average percentage of prenatal care is almost 65 percent in all the districts. Immunization is vaccination for controlling life threatening communicable diseases. The immunization is 78 percent on average in all the districts of Pakistan. On average, the population density of districts of Pakistan is 1239 inhabitants per kilometer square.

The data on MPI is utilized from the study of (Naveed and Ali 2012). This study used the PSLM (Pakistan Social and Living Standard Measurement, 2012-2013) survey data, which covered 77500 households. These MPI scores ranges from 0 to 1; the poverty level increases as we move from 0 to 1. The average score of MPI is almost 16 percent. Naveed and Ali (2012) has given equal weights (0.25) in the measurement of MPI scores to all the four indicators i.e. education, health, assets holdings and living conditions.

Private Healthcare Providers are entities that gain payment in exchange of producing health related activities. Hospitals, private practitioners, clinics, pharmacies, traditional providers are the examples of these Healthcare Providers (NHA, 2009-10). Pakistan Bureau of Statistics used mix strategy approach (survey and census) for the coverage of Private Healthcare Providers. Separate questionnaires were developed for census and survey. Small healthcare providers were covered in survey while the big hospitals in census. Providers were segregated by the hospital size. Number of beds were used to measure the hospital size. The hospitals with number of beds greater than 50 were considered as big hospitals and less than 50 as small healthcare providers. This was the very first time in Pakistan, the mixed strategy approach was used and faced very good response. The response for the census was 100 percent and 98 percent for the other providers.

1.4.3.1 Methodology of the Census

All the relevant information for big hospitals was collected from regional offices of PBS, Economic Census 2005 and hospital's websites. The number of big hospitals (functional in 2009-10) covered from all over the country were 125. The information was collected by the PBS's regional offices in their domain and a separate questionnaire was developed for census.

1.4.3.2 Methodology of the Survey

Four provinces of Pakistan were covered for survey and sample of 2,160 (primary sampling units) healthcare providers were selected. The following eight categories of health facilities were considered in the selected sample areas.

- Small hospitals (no of bed < 50).
- Special clinics

- General Practitioner clinics.
- Dental clinics
- Clinics run by Paramedical staff
- Diagnostic centers and Laboratories
- Traditional healthcare providers.
- Outpatient care clinics.

For survey, PBS used single stage stratified sample design. Primary sampling units (PSUs) were villages and enumeration blocks in the cities which contain 200 to 250 households. Urban area frame was developed for urban areas by PBS for all over the country. Healthcare facilities' acquired information regarding each enumeration block was used as measure of size. PBS adopted list of villages, from 1998 population census, as sample frame for rural areas.

The stratification for survey was scheduled as follows:

- PBS picked fourteen big cities from four provinces to establish an independent stratum. The selected cities were Lahore, Rawalpindi, Karachi, Gujranwala, Faisalabad, Multan, Sialkot, Bahawalpur, Sukkur, Islamabad, Hyderabad, Peshawar, Sargodha and Quetta.
- The excluded cities and villages/towns of each province were congregated to make another stratum.
- Within the domain of administrative division of all the four provinces, all the rural areas were pooled to form an independent stratum called rural stratum.
- Sub-strata were formed in each stratum of fourteen big cities to govern the disparities of health facilities. Stratum-I was having 25 or more health facilities in each village, Stratum-II has 10-24 healthcare facilities, Stratum –III having less than 10 and Stratum-IV has the villages which contain no healthcare facility.

PBS fixed the sample size to produce reliable results of the main variables at provincial level and the fixed size was 21,884 facilities from 2160 primary sampling units including 825 rural and 1335 urban blocks of the four provinces.

1.5 RESULTS AND DISCUSSION

This section is broadly divided into two main subsections according to the objectives of the study. In the first part, the findings of the efficiency measurement are discussed[12]. The spatial dependence of the efficiency scores of all the private hospitals[13] in the districts is discussed in the second part.

1.5.1 Efficiency Measurement

The first step of our empirical analysis is to measure efficiency of private hospitals without considering the prospective spatial interdependence between the units. Then, the efficiency scores are aggregated at district level[14]. The efficiency scores are measured by using Stochastic Frontier Analysis (SFA) production function taking inpatients and outpatients as dependent variables. SFA is a parametric technique of efficiency analysis and it is based on econometric regression model. It is parametric and requires functional form. It allows the random error along with the inefficiency term. One drawback of SFA however, is that it allows only one output. So, the main analysis of efficiency measurement used mean of efficiency score. The results are also discussed separately for outpatients and inpatients for heterogeneous analysis to show the efficiency level of private hospitals in case of Outpatients Department (OPDs) and inpatient care.

[12] The technical efficiency scores of all the private hospitals (big and small) on district level are provided in the appendix and efficiency scores at hospital level will be provided on request.
[13] These private hospitals include five type of hospitals e g Individual Proprietorship, Private Limited Company, Partnership, Trust and NGO/NPO.
[14] Taking mean of efficiency scores of all the hospitals of that specific district.

The efficiency score lies between 0 and 1: if the efficiency score is 1, it means that hospital is fully efficient and below 1, it is considered inefficient. The focus of current study is output oriented model[15]. So, the highest possible level of output should be achieved with scare resources for reducing the inefficiencies.

The findings of efficiency measurement reveal that not a single hospital lies on production frontier. Hence, out of 749 hospitals, no hospital was fully efficient. While taking the overall average of efficiency score as efficiency measure, the most efficient hospitals were "Buner Medical School" from Buner district and "Malik Medical Complex" from district Muzaffar Garh with efficiency score 0.73, which is almost 73 percent efficient and still 23 percent more output can be achieved with same inputs. These two hospitals are Individual Proprietorship hospitals. Whereas, the least efficient hospital was "Ramey Surgical Hospital and Maternity" from district Bahawalpur. Its efficiency score was 0.01 which is extremely low and there is 99 percent room for improvement. It is a partnership type hospital.

Considering the number of outpatients as output variable in efficiency measurement, "Manawar Hospital" was the most efficient hospital located in Faisalabad. While its efficiency score is 0.84 means it is 84 percent efficient and still there is 16 percent chance of betterment. It is a Partnership type hospital. The second most efficient hospitals are "Alam Hospital" from Gujrat and "Fatima Medical Centre" from Rajan Pur district. These two hospitals are Individual Proprietorship type hospitals. Whereas, there are various hospitals with zero efficiency score which is an alarming situation especially in a developing country like Pakistan. As, Pakistan is already facing the problems of scare resources in health sector.

[15] Obtained maximum output by utilizing given set of inputs.

There are two most efficient hospitals with efficiency score 0.80 while taking the number of inpatients as output variable in efficiency measurement. These hospitals are "Yousaf Surgical Centre" from Lodhran district and "Turbat Medical Centre" located in Turbat. The type of these hospitals are Individual Proprietorship. Still these two hospitals have 20 percent room for improvement. Conversely, the least efficient hospitals are plentiful. Alarmingly, there are five hospitals with zero efficiency score[16]. The overall average efficiency score of 749 private hospitals is 0.48. Hence, the overall hospitals are only 48 percent efficient and there is 52 percent chance of betterment. The average efficiency scores across four provinces of Pakistan are presented in the following table.

Table 1.2 Average Efficiency Scores at Province Level

Province	Efficiency Inpatients	Efficiency Outpatients	Efficiency Mean	Number of Hospitals
Punjab	0.45	0.36	0.41	417
Sindh	0.49	0.21	0.35	181
KPK	0.51	0.19	0.35	116
Baluchistan	0.47	0.20	0.34	35

The results show that most of the hospitals included in the analysis are from Punjab. Followed by Sindh and KPK and Baluchistan has only 35 hospitals. The average efficiency score of hospitals from Punjab is slightly higher than the other provinces. Same is the case when we consider the number of OPDs as output variable. Whereas, the situation is different when number of inpatients are considered as output in efficiency measurement. KPK's Hospitals are most efficient, followed by Sindh and Baluchistan. The average efficiency scores by hospital type are provided in the following table.

[16] "New Family Hospital" from Gujrat, "Hashmanis Hospital" from Karachi, "Iqbal Medical Centre" from Khushab, "Yahya Welfare Complex" from Haripur and "Zain Medical Hospital" from Faisalabad district.

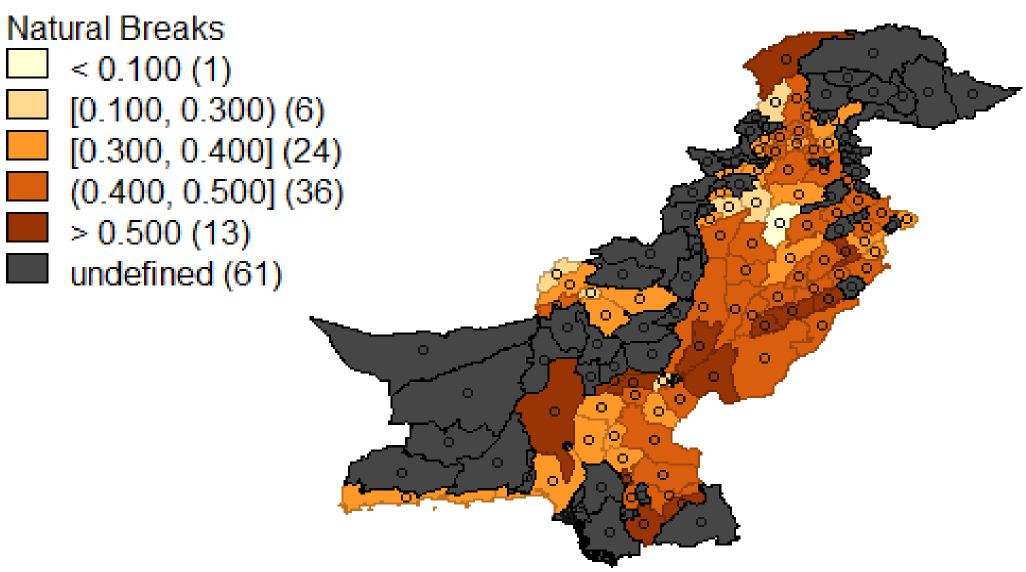
Table 1.3 Average Efficiency Scores by Hospital Type

Ownership Type	Efficiency Inpatients	Efficiency Outpatients	Efficiency Mean	Number of Hospitals
NGO/NPO	0.50	0.29	0.40	68
Individual Proprietorship	0.47	0.30	0.38	495
Private Limited Company	0.47	0.22	0.35	29
Partnership	0.43	0.23	0.33	82
Trust	0.47	0.36	0.42	67
Others	0.48	0.40	0.44	8

The results reveal that most of the hospitals are of type Individual Proprietorship. However, the most efficient ownership type is NGO/NPO but still 50 percent of output can be maximized with given resources even for relatively most efficient hospitals.

The efficiency scores at district level are provided in the appendix section and their summary is given in the following Figure.

Figure 1.1. Mean of average efficiency scores of outpatients and inpatients



Source: Author's own calculations

The aggregated findings at district level reveal that 61 observations are undefined, which means that data is not available for these districts. There were 141 districts in four provinces of

Pakistan at the time of survey. But due to missing data for some variables, this study has analyzed the hospitals from 80 districts. The results show that none of the districts is found to be fully efficient and all the hospitals have been functioning below the production frontier. Most of the districts' efficiency scores are found to be less than 50 percent. Whereas, the efficiency score of only 13 districts are greater than 0.5. The average efficiency score is approximately 40 percent, which is quite low. While, there is 60 percent chance of improvement.

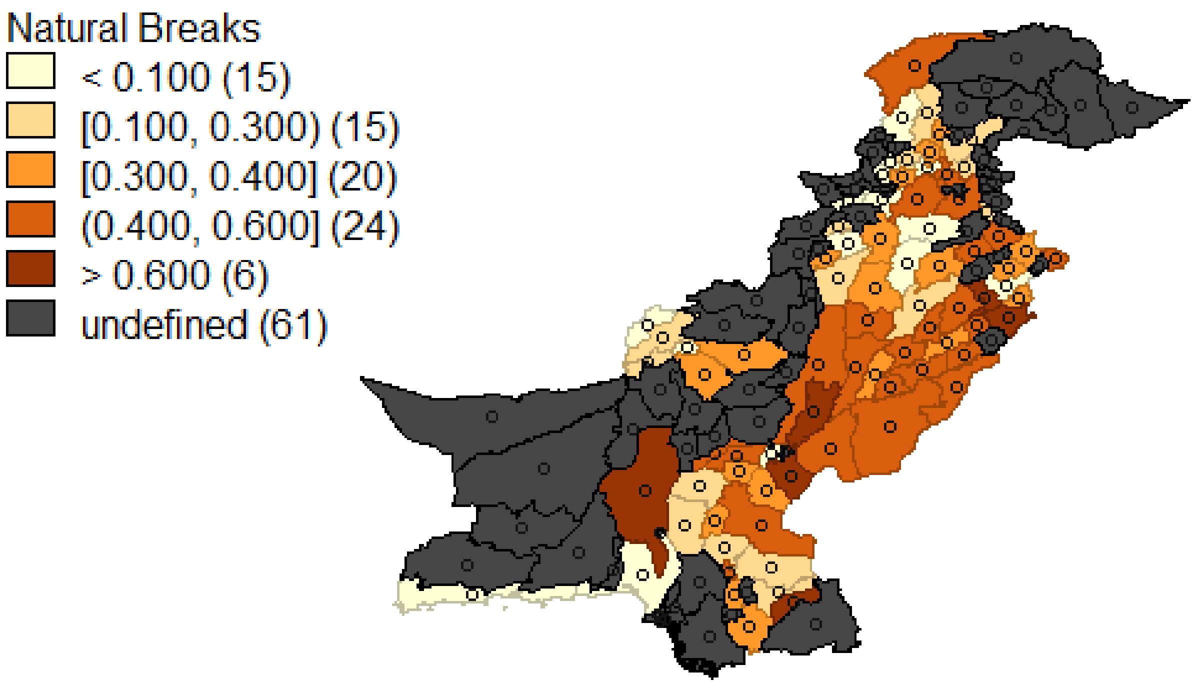
Matiari district from Sindh is the most efficient district while considering the mean of efficiency score measured by taking outpatients and inpatients as output. Its efficiency score is 0.64; however, still 36 percent output can be enhanced to reach at full efficiency level. This district is followed by Lodhran and Khuzdar that are almost 60 percent efficient. There is only one district Killa Abdullah for which efficiency score is less than 10 percent means 90 percent output can be increased.

The analysis has be done for efficiency scores achieved taking outpatients and inpatients separately for heterogeneous analysis. Furthermore, to explore whether private hospitals of Pakistan are more efficient in their daily OPDs or inpatients services. Outpatient service of a hospital is mainly the patients' visit to hospital for consultation. Moreover, no patient occupies a bed for any length of time. So, in this section efficiency scores are measured taking number of outpatients as output variable. Findings are aggregated at district level and efficiency scores at district level are provided in the appendix. Its summary is presented in the following figure.

The overall situation is almost homogeneous i.e. not a single district lie on the frontier. Hence, no district is fully efficient. The efficiency scores of six districts are greater than 60 percent and the most efficient district is Kasur located in Punjab. Its efficiency score is 0.76, which means it is 76 percent efficient and has almost 24 percent chance of improvement. Kasur is followed by

Umerkot and Nankana Sahib, both have almost 70 percent efficiency scores. Their level of efficiency can also be increased by 30 percent. It is an alarming situation that fifteen districts' efficiency scores are less than 10 percent while taking the outpatients as output. Hence, the private hospitals from these fifteen districts can enhance output by 90 percent with the available resources.

Figure 1.2 Average Efficiency Scores of Outpatients

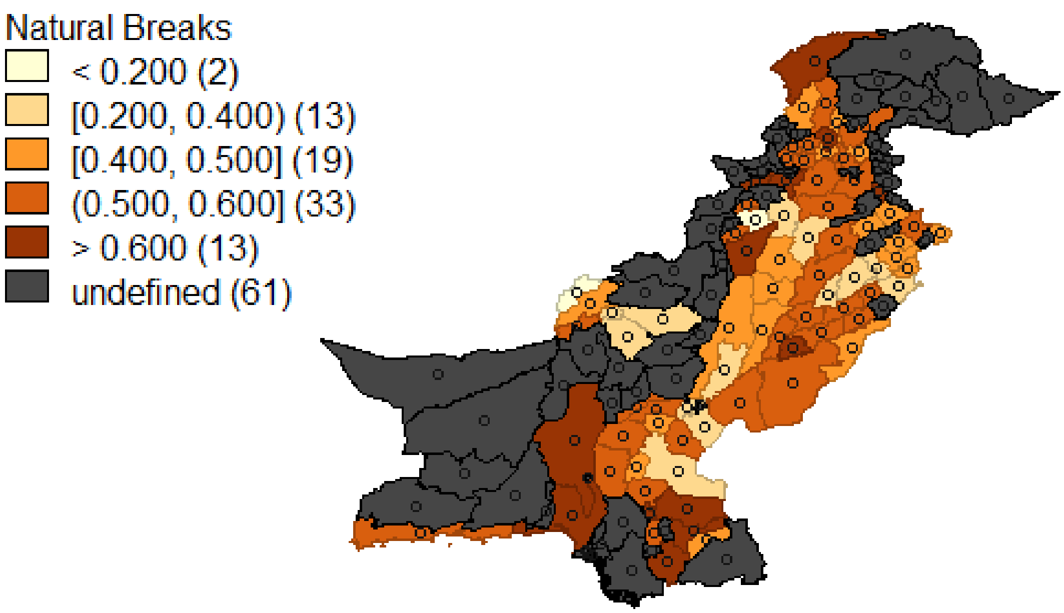


Source: Author's own calculations

The efficiency scores are also measured taking inpatients as output variable. Inpatient services are provided by all the considered hospitals in the analysis. Inpatient care is when a patient occupies a bed in that healthcare facility. In our analysis, there are mix of big and small hospitals but all these hospitals provide the facility of inpatients. The maximum efficiency level is achieved by the district Lodhran which is 72 percent. But it is 28 percent below the frontier.

The three districts D.I.Khan, Matiari and Upper Dir have nearly 70 percent efficiency score. They have 30 percent chance of betterment. Lakki Marwat and Killa Abdullah are the district whose efficiency scores are even less than 20 percent; it means that 80 percent below from frontier. These are the same districts that have least efficient scores while outpatients was taken as output variable. Therefore, the output level can be enhanced with these given resources. The efficiency scores with inpatients at district level are provided in the appendix. Its summary is presented in the following figure.

Figure 1.3 Average Efficiency Scores of Inpatients



Source: Author's own calculations

1.5.2 Spatial Analysis

The existence of spatial autocorrelation in efficiency indicators and control variables is checked using univariate Moran's I test and the results are presented in the table 1.4. The findings confirmed the existence of spatial autocorrelation among the efficiency indicator as the values of Moran's I test are positive and highly significant. For this purpose, inverse distance based weight matrix is used. Moran's I value is estimated using weight matrices with two distances[17] for sensitivity analysis. Therefore, values of Moran's I for efficiency indicators and control variables except population density are positive and highly significant for both the distances. It confirms the spatial dependence and spillover effects for all the variables.

Table 1.4 Univariate Moran's I test for Spatial Autocorrelation

Variables	Moran's I (d=1)	Moran's I (d=2)
Efficiency mean	0.178*** (0.08)	0.124*** (0.054)
Efficiency inpatients	0.149** (0.074)	0.106*** (0.05)
Efficiency outpatients	0.17** (0.08)	0.173*** (0.048)
Prenatal	0.402*** (0.081)	0.349*** (0.048)
Immunization	0.445*** (0.079)	0.385*** (0.051)
MPI	0.456*** (0.073)	0.393*** (0.053)
Density	0.011 (0.01)	0.01 (0.005)

Null Hypothesis: Values observed at one location do not depend on values observed at neighboring locations. Standard errors in parentheses and *** indicates p<0.01, ** indicates p<0.05, and * indicates p<0.1

Furthermore, to capture this spatial effect, we have applied spatial regression analysis. This analysis is done for three indicators of efficiency[18] to capture heterogeneous effects. Two type of weight matrices are used for sensitivity analysis. First is inverse distance weight matrix[19] and second is contiguity weight matrix[20]. For distance based weight matrices, the software packages take Euclidean distance[21]. In the literature of spatial econometrics, more than one type of weight

[17] Band 1 means 111 Kilometer and band 2 is 222 Kilometer.

[18] For overall analysis the average of outpatients and inpatients has taken and the separate analysis has also been done for inpatients care and OPDs to explore the existence of competition.

[19] Distance based weight is built on the average distance between the districts. If the average distance is 1 or less then it is considered as neighbor and otherwise not. Moreover, for sensitivity analysis, the distance is also increased in the analysis.

[20] The contiguity weight matrix indicates that the districts share the boundaries. If it shares the boundaries then value 1 is assigned to that units and if not then 0.

[21] To convert the Euclidean distance to the kilometers multiply the band by $R\pi/180$. Where R is the radius of the earth which is equal to 6371km (Banerjee et al., 2004). Therefore, Euclidean distance 1 is equal to 111 km and 2 is equal to 222 km.

matrix is used for robustness. Usually, it is used to check the strength of spillover effects with changing neighborhood's definition (Ahmed 2011). We begin with the classical OLS regression and two types of models are estimated for spatial regression analysis, spatial lag and spatial error model with both the weight matrices. Results of all the models while taking the average efficiency score as dependent variable are provided in the following table.

Table 1.5 below shows the regression results of OLS, spatial lag and spatial error models taking average efficiency score as dependent variable. We have started with classical OLS regression without spatial dependence. While taking the distance based weight matrix, at first distance four locations have no neighbors but when we have increased the distance than all the districts have at least one neighbor.

Table 1.5 Results of OLS, Spatial Lag and Spatial Error Models Taking Average Efficiency Score as Dependent Variable

Variables	Distance Based Weight Matrix						Contiguity Based Weight Matrix					
	Band=1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG
Prenatal	0.0035***	0.0034***	0.0035***	0.0035***	0.004**	0.0033***	0.0028**	0.0025**	0.025**	0.0028**	0.0303**	0.0284**
	(0.00117)	(0.0011)	(0.0011)	(0.0011)	(0.0013)	(0.0015)	(0.0012)	(0.0012)	(0.0118)	(0.0013)	(0.0117)	(0.0119)
Immunization	0.0025***	0.0025***	0.0025***	0.0025***	0.0026**	0.0027***	0.0024**	0.0025**	0.0023**	0.0024**	0.0255**	0.0024**
	(0.00091)	(0.0008)	(0.0008)	(0.0009)	(0.0008)	(0.0008)	(0.0011)	(0.00094)	(0.0012)	(0.0011)	(0.0094)	(0.0009)
MPI	0.650***	0.618**	0.6489***	0.6505***	0.637***	0.591**	0.4782**	0.4361**	0.4296**	0.4783**	0.4806***	0.4769***
	(0.2357)	(0.2301)	(0.224)	(0.2357)	(0.2225)	(0.225)	(0.1886)	(0.208)	(0.205)	(0.217)	(0.206)	(0.206)
Density	-0.00116	-0.00125	-0.000138	-0.00116	-0.00159	-0.00114	-0.00047	-0.00027	-0.0048	-0.00047	-0.00115	-0.00474
	(0.00148)	(0.00144)	(0.00158)	(0.0015)	(0.00154)	(0.0014)	(0.000158)	(0.00015)	(0.00149)	(0.00158)	(0.00148)	(0.0015)
Constant	-0.1744	-0.173	-0.1638	-0.175	-0.234	-0.188	0.127	0.1045	0.140	0.1277	0.159	0.128
	(0.0133)	(0.1688)	(0.131)	(0.133)	(0.1399)	(0.128)	(0.1404)	(0.1377)	(0.136)	(0.368)	(0.1299)	(0.154)
Rho			0.0178			0.2156			0.1558			0.0565
Lambda		0.1953			0.0423			0.112			-0.2	
Diagnostics												
Moran's I	0.993			0.648			1.008			0.2997		
Lagrange Multiplier	0.026			1.428			1.0688			0.0747		
Robust LM	0.092			6.16**			4.928**			1.3469		
Lagrange Multiplier (error)	0.368			0.013			0.2145			0.0088		
Robust LM (error)	0.434			4.744**			3.974**			1.281		

standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Furthermore, MPI is positively associated with the efficiency of hospitals at district level. Actually, the output oriented technical efficiency of a hospital is measured as the maximum output achieved by using given resources, so the hospitals of less developed areas use limited inputs i.e. doctors, specialists, other staff and number of beds to treat maximum patients (inpatients and outpatients). On the other hand, specialists and doctors don't prefer to live in less developed areas, so the hospitals have to treat more patients with fewer inputs. Therefore, the poverty has positive relation with the efficiency indicator of a hospital at district level. Finally, the demographic indicator population density does not exhibit significant impact on technical efficiency.

To capture the spatial interdependence among all the variables, spatial lag and spatial error model are mostly used in the literature (Felder and Tauchmann 2013, Longo, Siciliani et al. 2017). The suitable model can be selected by using Lagrange Multiplier (LM) test. The results of LM test are given in the diagnostic section of previous table. Results reveal that both LM lag and LM error are not significant.

Moran's I values from all the models are not significant showing non presence of spatial dependence but our results of univariate Moran's I indicated that spatial relationship exists in all the indicators. So, we disaggregated the analysis into two parts to identify whether the spatial dependence exists in OPDs or in inpatient care for private hospitals. So, we have estimated OLS, spatial lag and error model with contiguity and distance based weight matrix for efficiency scores for outpatients and inpatients separately. The results are provided in the tables 1.6 and 1.7. Table 1.6 shows the results of all the models for efficiency scores obtained from outpatients as dependent variable.

Table 1.6 Results of OLS, Spatial Lag and Spatial Error Models taking Outpatients as Dependent Variable

	Distance Based Weight Matrix						Contiguity Based Weight Matrix					
	Band=1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
Variables	**OLS**	**ERROR**	**LAG**	**OLS**	**ERROR**	**LAG**	**OLS**	**ERROR**	**LAG**	**OLS**	**ERROR**	**LAG**
Prenatal	0.0054** (0.0021)	0.0038 (0.0027)	0.005** (0.0021)	0.0054** (0.0021)	0.00383 (0.0022)	0.0043* (0.002)	0.0056** (0.0022)	0.0048** (0.0029)	0.0049** (0.0021)	0.0055** (0.0022)	0.005** (0.00194)	0.0051*** (0.0019)
Immunization	0.0033** (0.0016)	0.0033** (0.002)	0.00314 (0.00152)	0.0033* (0.00164)	0.0031* (0.0016)	0.0029 (0.0015)	0.0032* (0.00166)	0.0032* (0.0016)	0.0031* (0.0016)	0.00326* (0.0017)	0.002 (0.0015)	0.0238 (0.00147)
MPI	0.762* (0.423)	0.6351** (0.2722)	0.858*** (0.398)	0.8686** (0.342)	0.8266** (0.419)	0.791** (0.389)	0.768** (0.4273)	0.6609** (0.4178)	0.6857* (0.3971)	0.729* (0.427)	0.7152** (0.375)	0.745** (0.377)
Density	-0.00025 (0.00026)	-0.00032 (0.00026)	-0.000133 (0.000259)	-0.0025 (0.00266)	-0.00093 (0.00025)	-0.0002 (0.00246)	-0.0023 (0.0029)	-0.0073 (0.0026)	-0.0002 (0.00027)	-0.0023 (0.0029)	-0.00994 (0.00026)	-0.0001 (0.00026)
Constant	-0.343* (0.239)	-0.143 (0.166)	-0.507** (0.223)	-0.342* (0.239)	-0.3156* (0.261)	-0.452** (0.219)	-0.489** (0.241)	-0.3813 (0.2419)	-0.453** (0.229)	-0.489* (0.241)	-0.316 (0.227)	-0.502 ** (0.215)
Rho			0.306**			0.451***			0.2112*			0.53***
Lambda		0.429**			0.474***			0.2730*			0.517**	
Diagnostics												
Moran's I	2.439**			3.337***			2.104**			3.533***		
Lagrange Multiplier	4.152**			6.824***			2.6182			11.89***		
Robust LM	0.558			4.455**			0.9093			1.576*		
Lagrange Multiplier (error)	3.697**			3.931**			1.7			11.01***		
Robust LM (error)	0.103			1.562			0.265			0.0403		

Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 1.7 Results of OLS, Spatial Lag and Spatial Error Models Taking Inpatients as Dependent Variable

	Distance based weight matrix						Contiguity based weight matrix					
	Band=1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
Variables	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG
Prenatal	0.0017 (0.0015)	0.0011 (0.0019)	0.0015 (0.00142)	0.0017 (0.0015)	0.0016 (0.0014)	0.0015 (0.0014)	0.0135 (0.00158)	0.0012 (0.0015)	0.0124 (0.015)	0.00135 (0.178)	0.0138 (0.0149)	0.013 (0.0149)
Immunization	0.00193 (0.00116)	0.0019 (0.001)	0.00214 (0.0011)	0.0019 (0.0019)	0.00176 (0.0011)	0.0017 (0.0017)	0.0016 (0.00120	0.00163 (0.0012)	0.00156 (0.0012)	0.0016 (0.0012)	0.0179 (0.012)	0.0016 (0.0011)
MPI	0.4077** (0.3024)	0.475** (0.2911)	0.4872** (0.2856)	0.467** (0.3023)	0.4322 (0.339)	0.414* (0.296)	0.294 (0.2754)	0.2824 (0.2636)	0.2743 (0.261)	0.2946 (0.275)	0.2586 (0.255)	0.2838 (0.259)
Density	0.000013 (0.000019)	-0.00041 (0.00029)	-0.000803 (0.0002)	0.0013 (0.0019)	-0.0058 (0.0018)	-0.0011 (0.018)	-0.00044 (0.0002)	-0.00063 (0.00019)	-0.0048 (0.00189)	-0.00044 (0.0002)	-0.00081 (0.0018)	-0.0003 (0.00188)
Constant	0.125 (0.170)	0.215 (0.188)	0.193 (0.1731)	0.125 (0.17)	0.143 (0.171)	0.122 (0.1731)	0.2179* (0.178)	0.2238* (0.173)	0.171 (0.179)	0.198 (0.178)	0.2116 (0.172)	0.1237 (0.0192)
Rho			-0.1314			0.1453			0.0787			0.2312
Lambda		-0.156			0.0697			0.083			0.2786	
Diagnostics												
Moran's I	0.236			0.779			0.833			1.4365		
Lagrange Multiplier	1.315			0.491			0.228			0.885		
Robust LM	2.251			4.06**			2.826*			0.0967		
Lagrange Multiplier (error)	0.007			0.053			0.0923			1.022		
Robust LM (error)	0.942			3.62*			2.674			0.234		

Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results of OLS regressions are almost similar to what we discussed earlier. The Moran's I values of all the models using both weight matrices are positive and highly significant showing strong spatial autocorrelation. The Moran's I value of OLS for d=1 and contiguity of order 1 is significant at 5 percent. When we increase the distance and take the neighbors at order 2, the strength of spatial dependence increased.

Both the values of LM lag and LM error are significant using distance based weight matrix but the value of LM lag is slightly greater than the value of LM error. However, we have estimated both the models, so we can compare their results. For contiguity weight matrix of order 1, LM lag and LM error both are not significant and their robust values are also not significant but when we increase the circle of neighbors, both the values are highly significant. Therefore, we have estimated both the models with contiguity weight matrix.

The coefficient of spatial auto regression in spatial error model and spatial lag model is λ and ρ respectively. The findings show that the values of Lambda and Rho are positive and highly significant with both the weight matrices. It shows the existence of spatial dependence. So, there is evidence of positive spillover of efficiency of hospitals at district level while taking the outpatients as dependent variable, which shows the existence of competition in OPDs of private hospitals. Due to competition, the efficiency in OPDs of private hospitals in one location induces the private hospitals of neighbor location to increase the efficiency of their OPDs in order to increase their profit level. These results are supported by many studies (Herwartz and Strumann 2012, Felder and Tauchmann 2013, Lisi, Moscone et al. 2017, Longo, Siciliani et al. 2017).

To check whether this behavior of private hospitals is only seen in OPDs or they follow the same behavior with inpatients care. The same models have been estimated for inpatients to analyze the existence of competition and results are provided in table 1.7.

Table 1.7 shows the results of OLS, spatial lag and spatial error model taking the efficiency scores measured by inpatients as dependent variable. Results of OLS regression show that the coefficients of health indicators prenatal and immunization are positive but not significant in case of admitted patients. Whereas, the remaining results are similar to what we discussed earlier.

The spatial dependence does not exist in case of inpatients because the value of Moran's I for residuals is not significant in any case. So, the behavior of private hospitals is not same towards the outpatients and inpatients. So competition exists for OPDs in private hospitals but not for inpatient care. Therefore, spillover effects of efficiency have not been observed in case of admitted patients in private hospitals. An important reason behind this behavior could be the size of the hospitals as in the dataset, most of the hospitals are small.

Our analysis is based on the data set of 749 hospitals which are mixed as big (no of beds>50) and small hospitals (no of beds<50). Whereas, the big hospitals are 125 and small hospitals are 624, then this mixed data set is aggregated at district level for the spatial analysis. Two different behaviors are experienced from the same hospitals for two indicators; efficiency in OPDs and efficiency in inpatients care. To analyze this phenomenon, the given data-set of 749 hospitals is disaggregated at two levels, namely the big and small hospitals. The same analysis is done with big and small hospitals separately to explore the reasons behind two different behaviors for outpatients and inpatients care. Our analysis started with the small hospitals and at first we have taken the average efficiency scores as dependent variable. Table 1.8 shows the estimation results of OLS regressions, spatial lag and spatial error model using both weight matrices.

The OLS regression has been estimated and almost all the results are similar to the case of aggregated analysis except the demographic indicator. As, population density is taken as demographic indicator measured as the number of people per unit area (per square kilometer).

Previously, population density was not significant in average efficiency analysis of a hospital at district level but in case of small hospitals, population density has a negative and significant impact. Therefore, it means that in more dense areas the efficiency of the hospitals in a district is less as compared to less dense area. All the other covariates have similar results as discussed in case of aggregated analysis. Table 1.8 shows the results of OLS, spatial lag and spatial error models with both the weight matrices taking average efficiency as dependent variable in case of small hospitals.

Results in table 1.8 show that spatial dependence does not exists in case of small hospitals as the Moran's I values under all the models[22] are not significant. We have estimated both the models spatial lag and spatial error models for robustness and found that both the spatial coefficients, Lambda and Rho, are not significant which shows the absence of spillover effects of efficiency for small private hospitals. To further explore the efficiency of small private hospitals and their spill-over at district level, we have estimated the same models by taking the efficiency measured with inpatients and outpatients as dependent variables separately. The results of OLS, spatial lag and spatial error models with both weight matrices taking efficiency scores in OPDs are shown in table 1.9.

The estimation results in table 5 show the existence of spatial dependence as the values of Moran's I are positive and highly significant for all the models. According to the diagnostic, LM lag and LM error both the models are significant in all the cases. So, we have estimated both the models under all the specifications and found the existence of spatial dependence.

The values of the coefficient of spatial regression models (λ and ρ) are positive and highly significant. Therefore, it shows strong spatial dependence in efficiency of hospitals at district level.

[22] Distance based weight matrix (band =1 and band=2) and contiguity weight matrix (contiguity of order 1 and of order 2).

The small private hospitals show the same behavior as we have seen in the case of aggregated hospitals because the major portion of aggregated hospitals come from small hospitals.

In case of small private hospitals, the spillovers exist in their OPDs because mainly the small hospitals are specialized in outpatients and try to maximize their profit from daily OPDs instead of inpatients care. Usually, they have small number of beds for admitted patients. The size of the hospitals have real impacts on the health outcomes according to the recent literature (Kristensen, Olsen et al. 2008, Giancotti, Guglielmo et al. 2017). The next question arises that whether the profit seeking behavior of small private hospitals is present in only OPDs or does it also exist for admitted patients. This query is the basic motivation behind the estimation of all the models using the efficiency obtained from inpatients as dependent variable and estimation results are shown in table 1.10.

The findings reveal the absence of spatial autocorrelation for inpatients care in small hospitals, as the values of Moran's I are not significant in all the models with both the weight matrices. The values of spatial regression coefficients (λ and ρ) are not significant which show that spillovers of efficiency for small private hospitals in case of admitted patients don't exist. Hence, small private hospitals compete in OPDs to attract patients for profit maximization instead of inpatients. These interesting results motivate further to explore the behavior of big hospitals. Whether competition exists in big hospitals or not? If competition does exist then is it present in OPDs or in inpatient care? The big hospitals with more than 50 beds are believed to specialize in inpatient care.

Table 1.8 Results of OLS, Spatial Lag and Spatial Error Models taking Average Efficiency Score as Dependent Variable

Variables	Distance based weight matrix						Contiguity based weight matrix					
	Band=1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG
Prenatal	0.0028** (0.0011)	0.0022** (0.0011)	0.0028** (0.0011)	0.0028** (0.0011)	0.0029** (0.0012)	0.0025** (0.0011)	0.0028** (0.0114)	0.0032** (0.0105)	0.0028** (0.0011)	0.0028** (0.0014)	0.0028** (0.0011)	0.0027** (0.0011)
Immunization	0.0025*** (0.0011)	0.0025*** (0.0008)	0.0025*** (0.0008)	0.0024*** (0.0009)	0.0025** (0.0009)	0.0023** (0.0008)	0.0026** (0.0118)	0.0025** (0.0826)	0.0026** (0.0116)	0.0026*** (0.012)	0.0025*** (0.0086)	0.0025*** (0.015)
MPI	0.618*** (0.231)	0.576*** (0.227)	0.618*** (0.231)	0.618*** (0.231)	0.589*** (0.2245)	0.5719*** (0.223)	0.4452** (0.2318)	0.3489** (0.506)	0.3856** (0.222)	0.445** (0.2318)	0.4276** (0.518)	0.4435** (0.221)
Density	-0.0036** (0.00143)	-0.0039*** (0.0013)	-0.0036** (0.0013)	-0.0036** (0.00143)	-0.0035** (0.00139)	-0.0038** (0.00137)	-0.0036*** (0.0014)	-0.0034*** (0.0014)	-0.0036*** (0.0014)	-0.0036*** (0.0014)	-0.0036*** (0.0014)	-0.0037*** (0.0014)
Constant	-0.1469 (0.130)	-0.106 (0.115)	-0.1523 (0.1286)	-0.146 (0.130)	-0.157 (0.141)	-0.1638 (0.1258)	0.159 (0.131)	0.193 (0.117)	0.158 (0.128)	0.159 (0.131)	0.156 (0.125)	0.196 (0.141)
Rho			0.025			0.183			0.1723			0.153
Lambda		0.2177			0.0991			0.1659			0.118	
Diagnostics												
Moran's I	1.22			0.86			1.166			1.0214		
Lagrange Multiplier	0.062			0.884			1.3448			0.554		
Robust LM	0.087			2.505			1.9102			0.2805		
Lagrange Multiplier (error)	0.633			0.086			0.535			0.3313		
Robust LM (error)	0.657			1.708			1.1004			0.0577		

Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.9 Results of OLS, Spatial Lag and Spatial Error Models Taking Outpatients as Dependent Variable

Variables	Distance based weight matrix						Contiguity based weight matrix					
	Band= 1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG
Prenatal	0.0041* (0.0021)	0.0012 (0.0018)	0.0036 (0.00194)	0.0041* (0.0021)	0.0023 (0.0021)	0.0028 (0.0021)	0.048* (0.021)	0.037* (0.024)	0.0318* (0.0021)	0.048** (0.021)	0.0345* (0.0186)	0.0359* (0.0187)
Immunization	0.00314 (0.0016)	0.0027* (0.0015)	0.0027 (0.0015)	0.0032 (0.0016)	0.0027 (0.0016)	0.0026 (0.00153)	0.0031* (0.021)	0.00303* (0.0165)	0.00285* (0.0215)	0.0031* (0.022)	0.0177 (0.0152)	0.0023 (0.029)
MPI	0.8129** (0.3458)	0.5783** (0.3917)	0.8069** (0.3938)	0.8129** (0.4238)	0.7631** (0.403)	0.7296** (0.386)	0.6853** (0.4239)	0.5571* (0.959)	0.6018* (0.3962)	0.6853** (0.424)	0.6643** (0.3096)	0.7071** (0.3802)
Density	-0.00326 (0.0026)	-0.00645*** (0.0023)	-0.0045* (0.0025)	-0.0033 (0.0026)	-0.0049** (0.0024)	-0.0043* (0.0024)	-0.0032 (0.0026)	-0.0043** (0.0024)	-0.0038* (0.0025)	-0.0032 (0.0026)	-0.0037 (0.0023)	-0.0036* (0.0024)
Constant	-0.446 (0.2388)	-0.032 (0.151)	-0.466 (0.2212)	-0.259 (0.2388)	-0.243 (0.251)	-0.411 (0.218)	-0.045 (0.239)	-0.3245 (0.244)	-0.400 (0.223)	-0.045 (0.239)	-0.2557 (0.2239)	-0.457** (0.217)
Rho			0.294**			0.4635***			0.2722*			0.4906***
Lambda		0.50***			0.524***			0.3147** (0.0704)			0.4699**	
Diagnostics												
Moran's I	2.435**	0.045	0.129**	3.867***	0.083**	0.105**	2.748***			3.6719***		
Lagrange Multiplier	3.413*			8.493***			4.55**			10.14***		
Robust LM	0.21			0.196			0.0002			1.436		
Lagrange Multiplier (error)	3.531*			8.514***			4.908**			8.765***		
Robust LM (error)	0.329			0.218			0.354			0.0647		

Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.10 Results of OLS, Spatial Lag and Spatial Error Models Taking Inpatients as Dependent Variable

	Distance based weight matrix						Contiguity based weight matrix					
	Band=1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
Variables	**OLS**	**ERROR**	**LAG**	**OLS**	**ERROR**	**LAG**	**OLS**	**ERROR**	**LAG**	**OLS**	**ERROR**	**LAG**
Prenatal	0.0016 (0.0015)	0.00013 (0.0014)	0.0012 (0.0014)	0.0015 (0.0016)	0.0015 (0.0014)	0.0013 (0.0014)	0.0159 (0.0146)	0.0176 (0.0136)	0.0156 (0.014)	0.0159 (0.0146)	0.0153 (0.0139)	0.0154 (0.0139)
Immunization	0.0021 (0.0012)	0.0022* (0.0011)	0.0022* (0.0011)	0.0019 (0.0012)	0.0019 (0.0012)	0.0018 (0.0011)	0.0019* (0.014)	0.0197* (0.0108)	0.0019* (0.014)	0.0019* (0.014)	0.0218* (0.0112)	0.0021* (0.0136)
MPI	0.4508* (0.2991)	0.4428* (0.2761)	0.454* (0.283)	0.4508* (0.299)	0.388 (0.0011)	0.191 (0.294)	0.282 (0.298)	0.3804 (0.169)	0.272 (0.285)	0.282 (0.298)	0.2334 (0.646)	0.261 (0.284)
Density	-0.0047** (0.0018)	-0.0052** (0.00016)	-0.00428** (0.00176)	-0.0047** (0.00186)	-0.0037* (0.00182)	-0.0039** (0.00176)	-0.0041** (0.0018)	-0.0042** (0.0017)	-0.0041** (0.0018)	-0.0041** (0.0018)	-0.0047** (0.0017)	-0.0041** (0.0017)
Constant	0.1348 (0.1685)	0.268 (0.139)	0.2122 (0.1718)	0.154 (0.168)	0.145 (0.167)	0.0624 (0.173)	0.2327* (0.168)	0.1202 (0.1535)	0.122 (0.171)	0.127 (0.168)	0.112 (0.162)	0.146 (0.185)
Rho			-0.0929			0.221			0.0569			0.2031
Lambda		-0.1195			0.1317			-0.026			0.2718	
Diagnostics												
Moran's I	0.585			1.035			0.2607			1.56		
Lagrange Multiplier	0.737			1.178			0.125			0.7655		
Robust LM	1.688			5.104**			4.272**			0.1867		
Lagrange Multiplier (error)	0.051			0.2			0.014			1.124		
Robust LM (error)	1.002			4.125**			4.16**			0.545		

Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

After the analysis of small hospitals, our study has investigated the behavior of big hospitals[23]. The results with average efficiency scores as dependent variable are shown in table 7. First of all OLS regression has been estimated with both types of weight matrices. Almost all the results of covariates are similar as discussed previously. Whereas, the values of Moran's I are not significant which show that spatial autocorrelation does not exist with both weight matrices. The values of LM lag and LM error are also not significant. Therefore, we have estimated both the models spatial lag and spatial error with both the weight matrices for robustness.

The coefficients of spatial lag and spatial error models are also not significant. One of the reason could be most of the big hospital resides in 24 districts. So, this spatial analysis is carried out at district level and we have data for only 24 districts out of 141 districts. Hence, the main reason behind the non-existence of spillover effects in big hospitals could be the missing data for most of the districts. To further explore the behavior of big hospitals all the models have been estimated for efficiency from outpatients and inpatients separately.

The results of OLS, spatial lag and spatial error models with both the weight matrices taking efficiency measured using outpatients and inpatients are shown in table 1.12 and table 1.13 respectively.

[23] Big hospitals are hospitals whose number of beds are greater than 50.

Table 1.11 Results of OLS, Spatial Lag and Spatial Error Models Taking Average Efficiency as Dependent Variable

Variables	Distance based weight matrix						Contiguity based weight matrix					
	Band=1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG
Prenatal	0.0069** (0.0031)	0.0073*** (0.0027)	0.0064** (0.0027)	0.0069** (0.0031)	0.0068*** (0.0025)	0.0056** (0.0025)	0.0551 (0.0032)	0.0554 (0.0259)	0.0596 (0.0264)	0.0055 (0.1022)	0.0597 (0.0023)	0.0633 (0.0258)
Immunization	0.0038 (0.0022)	0.0029 (0.0021)	0.0048** (0.0023)	0.0038 (0.0022)	0.0041** (0.0020)	0.0055*** (0.0019)	0.0041 (0.0025)	0.0362* (0.0179)	0.0043* (0.0019)	0.0042 (0.0024)	0.0414** (0.0217)	0.0039** (0.0019)
MPI	0.3789 (0.5737)	0.5648 (0.5252)	0.1519 (0.5636)	0.3789 (0.5736)	0.2752 (0.5503)	-0.4066 (0.593)	0.3498 (0.403)	0.341 (3518)	0.0358 (0.3316)	0.3498 (0.4027)	0.5619* (0.2879)	0.4421 (0.324)
Density	-0.00135 (0.00139)	-0.0099 (0.0012)	-0.00155 (0.0012)	-0.0014 (0.0014)	-0.0013 (0.0011)	-0.0059 (0.0014)	-0.0039 (0.0015)	-0.0026 (0.135)	-0.0035 (0.0012)	-0.0039 (0.0015)	-0.0064 (0.0012)	-0.0066 (0.0018)
Constant	-0.6977* (0.374)	-0.6487* (0.333)	-0.6984** (0.311)	-0.6978* (0.374)	-0.7061** (0.3051)	-0.5595* (0.2971)	-0.076 (0.382)	-0.0768 (0.274)	-0.0918 (0.318)	-0.076 (0.382)	-0.1926 (0.2868)	-0.0103 (0.328)
Rho			-0.0875			-0.4275**			0.252 (0.348)			-0.277
Lambda		-0.064			0.054			0.0585			-0.4865	
Diagnostics												
Moran's I	-3.318			-1.429			-0.7191			-0.6656		
Lagrange Multiplier	0.123			0.89			0.0166			0.541		
Robust LM	0.058			0.952			0.0685			0.9569		
Lagrange Multiplier (error)	1.37			0.101			0.0311			0.849		
Robust LM (error)	1.305			0.163			0.083			1.2649		

Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.12 Results of OLS, Spatial Lag and Spatial Error Models Taking Outpatients as Dependent Variable

Variables	Distance based weight matrix						Contiguity based weight matrix					
	Band = 1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG
Prenatal	0.0053 (0.0067)	0.0053* (0.0031)	0.0039 (0.0057)	0.0053 (0.0067)	0.0081** (0.0033)	0.0018 (0.0051)	0.0674 (0.061)	0.0689 (0.048)	0.0668 (0.0474)	0.0067 (0.061)	0.0674 (0.6146)	0.0672 (0.0516)
Immunization	0.006 (0.0048)	0.0096*** (0.0028)	0.0087* (0.0049)	0.006 (0.0048)	0.103*** (0.0028)	0.0116*** (0.0042)	0.069 (0.0045)	0.0723** (0.033)	0.0078** (0.0035)	0.0069 (0.0045)	0.0689* (0.038)	0.0069* (0.0038)
MPI	0.243 (1.25)	0.0524 (0.632)	-0.2589 (1.101)	0.122 (1.25)	-1.251 (0.7923)	-0.8499 (0.9937)	0.387 (0.771)	0.5133 (0.664)	0.2192 (0.6051)	0.3879 (0.6678)	0.3906 (0.648)	0.3857 (0.649)
Density	-0.0026 (0.0033)	0.0051 (0.0019)	-0.0031 (0.0025)	-0.0026 (0.0033)	0.0055 (0.0018)	-0.0015 (0.0023)	-0.0026 (0.0028)	-0.0031 (0.0026)	-0.0028 (0.0021)	0.00265 (0.0028)	0.0026 (0.0235)	0.00264 (0.0759)
Constant	-0.6327 (0.8145)	-0.0314 (0.0618)	-0.0689 (0.6733)	-0.6327 (0.8145)	0.2087 (0.1615)	-0.5835 (0.5952)	-0.643 (0.0731)	-0.6728 (0.494)	-0.4724 (0.3070)	0.086 (0.731)	0.6491 (0.4181)	0.6441 (0.351)
Rho			-0.1981			-0.7903**			-0.4724			0.0076
Lambda		-1.177			-1.366***			0.6228**			-0.012	
Diagnostics												
Moran's I	-2.159			-1.03			-0.7918			0.4747		
Lagrange Multiplier	0.773			1.586			1.1779			0.0003		
Robust LM	0.583			0.202			0.0024			0.0248		
Lagrange Multiplier (error)	3.108*			1.405			1.2083			0.0004		
Robust LM (error)	2.918*			0.021			0.0328			0.0252		

Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.13 Results of OLS, Spatial Lag and Spatial Error Models Taking Inpatients as Dependent Variable

Variables	Distance based weight matrix						Contiguity based weight matrix					
	Band=1			Band = 2			Contiguity of Order 1			Contiguity of Order 2		
	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG	OLS	ERROR	LAG
Prenatal	0.0085 (0.0049)	0.0064 (0.0051)	0.0082* (0.0042)	0.0085 (0.0049)	0.0078 (0.0053)	0.0088** (0.0041)	0.0066 (0.0047)	0.0598 (0.0384)	0.0612 (0.039)	0.0658 (0.0461)	0.0656 (0.0391)	0.0649 (0.039)
Immunization	0.0016 (0.0035)	0.0032 (0.0034)	0.0019 (0.0033)	0.0016 (0.0035)	0.0021 (0.0034)	0.0015 (0.0031)	0.0004 (0.0034)	0.0064 (0.029)	0.0027 (0.0028)	0.0035 (0.0034)	0.0211 (0.0279)	0.00028 (0.0028)
MPI	0.5436 (0.9081)	0.2486 (0.7952)	0.4244 (0.9495)	0.5436 (0.9081)	0.4572 (0.8511)	0.9486 (1.09)	0.1192 (0.582)	0.1484 (0.478)	0.181 (0.4919)	0.119 (0.5821)	0.1547 (0.4932)	0.135 (0.489)
Density	0.0012 (0.0022)	-0.0017 (0.0019)	0.0027 (0.0019)	0.0012 (0.0022)	0.0014 (0.0018)	-0.0021 (0.0019)	0.0011 (0.0021)	0.0078 (0.0017)	0.0017 (0.0018)	0.0011 (0.0021)	0.0011 (0.0018)	0.0099 (0.0018)
Constant	-0.7461 (0.5923)	-0.6891 (0.5415)	-0.7356 (0.5012)	-0.7461 (0.5923)	-0.7106 (0.5385)	-0.845 (0.5305)	0.4466 (0.5518)	0.6061* (0.4767)	0.435 (0.256)	0.544 (0.552)	0.5712 (0.4658)	0.4948 (0.4023)
Rho			-0.0361			0.1669			0.2793			0.1514
Lambda		0.0935			0.051			0.3154			0.1268	
Diagnostics												
Moran's I	2.538**			1.902*			1.9622**			0.7482		
Lagrange Multiplier	0.001			0.054			1.3755			0.0804		
Robust LM	1.057			0.587			0.2966			1.0496		
Lagrange Multiplier (error)	1.925			0.882			1.503			0.0384		
Robust LM (error)	2.982*			1.414			0.4242			1.0076		

Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.12 shows the estimations results of OLS, spatial lag and spatial error for efficiency using outpatient. The results indicate the absence of spatial autocorrelation in OPDs as the values of the Moran's I are insignificant under all the specifications with both the weight matrices. Hence we can conclude that competition is not present in OPDs in case of big hospitals.

The coefficients of spatial regression $\lambda \; and \; \rho$ are highly significant and negative. So, the results show negative spillover effects of efficiency in case of outpatients. Negative spatial dependence might be described by competition between patients and on the other hand, it can be occurred due to some market constraints (Herwartz and Strumann, 2012, Cavalieri et al., 2017).

Table 1.13 shows the results of OLS, spatial lag and spatial error models for efficiency achieved from inpatient. The results indicate the spatial autocorrelation exists as the Moran's I values are positive and significant. As the big hospitals have more beds as compared to the small ones, so these hospitals specialized in inpatients care. According to our results, competition in efficiency exists in inpatients care in big hospitals.

As the analysis of big and small hospitals has been completed and it has determined that the spatial dependence exists for efficiency when it is estimated with outpatients as output, while, spillovers are absent when the efficiency is estimated with inpatients in case of small hospitals. Conversely, competition is present in patients care in case of big hospitals. One major reason behind this behavior might be the profit motives of private hospitals. According to the literature, size of a hospital impact the final health outcome. Since, small hospitals are specialized in ambulatory care department and they compete in this department with their neighbor regions to attract patients for achieving maximum profit. Whereas, the case of big hospitals is opposite, their main focus is inpatients for profit earning because of their size.

1.6 CONCLUDING REMARKS

The study has explored the existence of competition in efficiency of private hospitals of Pakistan at district level. It covers almost all the districts from four provinces of Pakistan. Firstly, we have estimated the technical efficiency scores of all private hospitals using Stochastic Frontier Analysis. The existence of spatial autocorrelation is verified by Moran's I test and we found the evidence of regional spatial dependence. Then we have estimated Spatial Regression Models by Maximum Likelihood Method and observe the presence of regional dependence for different cases.

To execute the analysis, data of private hospitals has been taken from PBS. The census and survey was conducted in 2010/11 by PBS using mixed strategy approach. Healthcare providers are broadly categorized into two groups. Small healthcare providers are defined as the providers which have less than 50 beds and covered under survey, whereas, providers with more than 50 beds were covered under census.

According to the findings of the study, the overall efficiency scores of all the private hospitals are not satisfactory. As not a single hospital is fully efficient; none of the hospital is working on the production frontier. Therefore, all the hospitals can increase their output level using the same level of resources. Efficiency scores are estimated for two outputs, outpatients and inpatients, separately for heterogeneous analysis.

The data is aggregated at regional level for the second stage of analysis. We have found the evidence of spatial dependence by univariate Moran's I test for all the variables, but the subsequent spatial regression analysis did not support this result. So, we have disaggregated the analysis to identify whether the spatial dependence exists in outpatients department or in inpatients care. Our results of Moran's I indicate the existence of regional spatial dependence. Therefore, we have disaggregated the analysis into two main parts; spatial analysis for efficiency measured in outpatients department and for inpatients.

Spatial regression analysis shows the existence of spatial dependence and positive spillovers of efficiency of hospitals at regional level while taking outpatients as dependent variable. This shows competition exists in OPDs of private hospitals. However, increase in efficiency in OPD of a hospital in one location induces the others to enhance their efficiency level. So, they can increase their profit levels by increasing their efficiency. However, spatial dependence has not been observed for inpatients. So, behavior of private hospitals is not similar towards outpatients and inpatients, as spillover of efficiency has been observed in OPDs but not for inpatients.

To explore the reasons behind this behavior of hospitals, we have further disaggregated the analysis into two main parts according to the size of a hospital. The given dataset of 749 hospitals is disaggregated into two categories; big hospitals and small hospitals. We have 624 small hospitals and 125 big hospitals in our dataset.

The estimation results showed the spatial dependence in OPDs in case of small hospitals but not for inpatients care, whereas, for big hospitals the spillovers are observed in case of inpatients instead of OPDs. According to the empirical literature, the size of the hospital has real impact on the final health outcome (Giancotti, Guglielmo et al. 2017). As the small hospitals specialized in ambulatory care, therefore hospitals compete with their neighbors to attract more patients for increasing profit levels. Contrary to it, competition has been observed in inpatients care in case of big hospitals. As the positive spillover of technical efficiency is observed for private hospitals means rise in the efficiency of one district's hospital cause the increase of efficiency of its neighboring district's hospitals. Hence at the same time both (neighbor) the district's hospitals are successful in attracting more patients. There can be two potential reasons for this behavior. First, private hospitals are not fully absorbed meaning all the patients are not getting treatment in the hospitals. Secondly, private hospitals are attracting patients from public hospitals (e.g. due to low quality, reputation, provided services etc.).

The major policy implication, which can be drawn from these findings is that, government should be focused on the efficiency of public hospitals to avoid the private sector exploitation in hospital sector. Secondly, it is suggested that policy interventions in terms of skill improvement or new technology adaptation that could increase the quality of a hospital will certainly be spread out to the hospitals of the other districts. While, the private hospitals are not directly under the control of Government, this policy intervention can be through reducing the import duties on new technology.

The second stage analysis is done on district level data due to data (geographical data at hospital level) limitations. Better understanding of the hospital behavior can be achieved with hospital level data. This may be an important gap for future research.

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Chapter 2

DOES EFFICIENCY AFFECT QUALITY? EVIDENCE FROM PUBLIC HEALTHCARE FACILITIES IN PAKISTAN

2.1 INTRODUCTION

The term infrastructure covers various activities relating to social, physical and economic overhead capital, that are liable for creating favorable environment for productive activities in all sectors of an economy. Infrastructure stock is basically divided into social infrastructure and physical/economic infrastructure. Health and education facilities are included in the social infrastructure whereas, economic infrastructure covers the services like transport, electricity, roads, communications, water system, and irrigation etc., (World Development Report, 1994). The development of social infrastructure is very important for a country because it represents the human face of economic growth process. For the progress of any society, universal access to health, education and safe drinking water is essential.

Health is an important factor that defines welfare of the society and has a crucial role in forming human capital, which ultimately contributes to economic growth. Health conditions that affect a nation’s population, in turn represent prevailing health situation within the country. According to World Bank (1993), improved health accords to economic growth in four ways; Firstly, production loses are reduced which may incur due to worker’s illness; Secondly, natural resources which otherwise would have been inaccessible can be utilized; Thirdly, given improved health, more children have the chance towards education and increased learning capacity; Lastly, an individual can better spend his/her resources, which may otherwise have been used towards treatment of the illness.

Pakistan is the sixth largest populous country that has experienced rapid growth from an estimated population of 180.71 million in 2011/12 to recent figure of 207.78 million as per 2017 Census (Pakistan Bureau of Statistics, 2017). The average population growth rate from 1998 to 2017, stood at 2.4 percent. Given this substantial growth, it is likely that the socio-economic development may face adverse consequences. Thus, it is vital to maintain balance between resources and population which is possible if healthcare providers efficiently utilize given resources.

The health status of women and children reflect the level of national health, quality of civil life, and social civilization. Accelerating the development of maternal and child healthcare is of great importance in improving a nation's health quality, promoting economic development and building a harmonious society (Wang, 2016). Health indicators in Pakistan remain very poor, as maternal, neonatal and infant mortality rates are fallen behind other comparable developing countries especially related to mother and child health (CPR, TFR, MMR & PGR etc.)[24] (Bhutta and Hafeez 2015, Pasha, Saleem et al. 2015, Ahmed and Won 2017). Due to slower reduction in these rates, it is reasonable to question the efficiency of healthcare providers, as enhancement in the efficiency may improve mother and child health. This in turn will contribute towards progress of human capital formation (Shaikh 2015). As, Pakistan does not have vast financial resources so there is a need high efficiency scores of the hospitals should be able to produce more healthcare with less resources. The efficiency analysis of the healthcare units in Pakistan is an unexplored research area which calls for attention, especially by policymakers and research scholars. Hence,

[24] CPR (Contraceptive prevalence rate) is the proportion of women of reproductive age who are using a contraceptive method. TFR is the total fertility rate, MMR is the maternal mortality rate and PGR is the population growth rate, Jabeen et al., 2011. MMR (Maternal Mortality Rate) is 276 per 100,000 live births and the under-five child mortality rate is around 89 deaths per 1,000 live births

it is of utmost importance to conduct an efficiency analysis of the healthcare units that are responsible for mother and child health.

This chapter seeks to establish whether there is a trade-off between quality and efficiency in hospitals in Pakistan, in other words, whether the hospitals that manage to provide high volume of healthcare with relatively scarce resources also provide high quality care. The direction of this relationship is especially important in developing countries as Pakistan, since scarce financial resources often require the policymakers to make decisions between funding fewer high quality centers or several smaller health units.

As discussed above, just focusing on efficiency measurement and ignoring other aspects such as quality of care, may produce misleading results and subsequently wrong policy conclusions. To increase the validity of results, the analysis should be performed to understand full range of hospital functions including perspectives of patients, staff and community (Hajialiafzali, Moss et al. 2007). If the hospitals are tasked with the single objective of increased efficiency, it may induce the management to compromise on quality of services. If a trade-off exists between efficiency and quality, then increasing efficiency may lead to deterioration in service quality.

The relationship between quality and efficiency, though important is quite an understudied topic worldwide, with complete lack of literature in terms of Pakistan's healthcare system. Very few studies have made an attempt to incorporate quality as an output in efficiency analysis with even fewer studies having explored the relationship between the two. (Valdmanis, Kumanarayake et al. 2004, Clement, Valdmanis et al. 2008, Navarro-Espigares and Torres 2011, Kang, Bastian et al. 2017). For instance, some researchers found a negative relationship between quality and operational efficiency of the hospitals (Morey, Fine et al. 1992, Maniadakis, Hollingsworth et al.

1999). Whereas, some other established a positive association between the two (Clement, Valdmanis et al. 2008, Nayar and Ozcan 2008).

However, these studies mainly focus on developed countries and their results are inconclusive. Healthcare system of developed countries is incomparable to developing countries, due to various challenges[25] that the latter face. There are very few studies (Campbell, Duke et al. 2008, Ntoburi, Wagai et al. 2008) regarding the performance and quality measurement of the hospitals in less developed countries. Thus, given the socio-demographic realities as mentioned earlier and unstable and diverse macroeconomic conditions of Pakistan, there is an urgent need to estimate the efficiency of public hospitals and further evaluate the relationship between efficiency and quality indicators. The absence of such studies identifies an important research gap, and therefore, this study is an attempt to assess efficiency of healthcare system in Pakistan.

This study aims to investigate the technical efficiency of the District and Tehsil Headquarter hospitals, Civil Hospitals along with rural health centers in the context of maternal, newborn and child health programs.[26] Furthermore, to examine the relationship between the efficiency of above mentioned healthcare providers and the quality of the services provided.

Welfare of people is directly related to healthcare services, and its provision is to be ensured by the government. Therefore, it is very important for the hospitals to efficiently utilize resources. Considering the significance of hospital performance, this study will highlight factors that cause inefficiencies. However, focusing only on the efficiency scores of the healthcare units could

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[25] Scare resources, high population growth rate, an insistently high neonatal mortality rate, and high maternal and infant mortality rates etc.

[26] Technical efficiency is output maximization given a level of inputs. Allocative efficiency which requires data related to prices of inputs and outputs, expenditures and revenues, cannot be estimated due to data limitation. This is discussed in detail in chapters on theoretical model and methodology.

potentially mislead policy measures. In this scenario, paving the path for policy making, the analysis of the relationship between quality and efficiency is crucial.

The contribution of this study is threefold: To begin with, to the best of our knowledge, this is the first study which explores the performance of public sector healthcare units in the context of mother and child health in Pakistan. Previous studies have very limited geographic coverage and hence face the problem of external validity. The current study covers the entire country and hence its results can be generalized. Secondly, to our knowledge, there has not been a single study examining the relationship between efficiency and quality in a low-middle income country. Thirdly, it also adds to the existing public health literature that explores the correlates of the quality of service provision.

The results of the first stage reveal that efficiency level of all the public hospitals are quite low in Pakistan. The technical efficiency of a public hospital is negatively related to the number of maternal and neonatal deaths which shows the positive association between technical efficiency and objective quality of a hospital. The findings of this chapter suggest that risk of maternal and neonatal mortality is relatively higher in less efficient hospitals as compared to the more efficient ones.

Rest of the chapter is organized as follows: the detail about the public healthcare system of Pakistan is provided in the second section. The third section presents comprehensive literature review. Theoretical background about the relationship between technical efficiency and quality, efficiency measurement and 2SRI is explained in fourth section. The fifth section explains data, variables and econometric methodology. Results are discussed in sixth section and seventh section provides the concluding remarks, some policy suggestions and future research gap. Limitations of the study are presented in the last section.

2.2 PUBLIC HEALTHCARE SYSTEM OF PAKISTAN

Health system of Pakistan mainly constitutes public and private sectors. Basically health is the responsibility of provincial government under the constitution of Pakistan, excluding the territories which are administrated by Federal government. However formulating and planning the national health policies is mainly the responsibility of Federal government whereas provincial governments are accountable for the implementation of these policies. Whereas the implementation of some vertical programs likes malaria, AIDS and immunization is the responsibility of Federal Ministry of Health (MOH).

Mainly Minister of health is the head of the federal MOH and Secretary is the completely in charge at bureaucracy level assisted by Director General, Chief and two Joint Secretaries. The Provincial Health Secretary exercises control over the provincial health policy, budget and the teaching hospitals and other institutions in the province. Health service delivery is being systematized through promotive, preventive, rehabilitative and curative services. The rehabilitative and curative services are being provided at the secondary and tertiary level whereas promotive and preventive services are provided by several national programs and primary healthcare facilities are under the provision of community health workers.

2.2.1 Public Healthcare Organization

The functions of public healthcare delivery system of Pakistan are managed at the district level administratively. Primarily the health becomes the responsibility of provincial government after the 18^{th} constitutional amendment, on June 30, 2011 whereas the federal government plays a coordinating role. Formerly the federal ministry was authorized with technical assistance, policy making, training, coordination and looking for foreign assistance. After the 18^{th} constitutional amendment, the power has been transferred to the provincial government.

The healthcare provision is divided into primary, secondary and tertiary healthcare. Primary healthcare is provided through Basic Health Units (BHUs), Rural Health Centers (RHCs), Maternal and Child Health Centers (MCHCs) TB centers and Dispensaries. All of these sources provide 8/6 OPD services (preventive and curative) whereas RHCs provide 24/7 curative services. A BHU covers 10000 to 15000 people and 5 – 10 BHUs are attached to a RHC. A RHC covers about 30000 to 45000 people. Mainly it delivers health preventive and primitive services such as immunization, maternal and child health services, diarrheal disease control, child spacing, malaria control, mental health, school health services, provision of essential drugs and prevention of locally endemic diseases. MCHCs are a part of integrated health system and it focuses on the child and maternal health. There are 1084 MCHCs and 5798 BHUs in Pakistan. The number of RHCs is 581 in the country and each RHC has 10 to 20 beds. They have services of minor surgeries, x-rays, laboratory and extensive outpatient services. Each RHC has 30 employees whereas each BHU has staff of 10 people (National Health Accounts, 2013).

Secondary healthcare facilities include acute, ambulatory and inpatient care and these services are provided by Tehsil Headquarter Hospitals (THQs) and District Headquarter Hospitals (DHQs). THQs cover 100,000 to 300,000 people and DHQs cover 1-2 million persons. Each THQ has 40-60 beds and they typically provide services of surgery, x-rays and laboratory services. The staff consists of at least three specialists: gynecologist and an obstetrician, a general surgeon and pediatrician. DHQs have typically 100-150 beds and the staff includes at least 8 specialist including anesthetist and obstetrician. There are 1,026 THQs, DHQs and RHCs in Pakistan. Under the administration of provinces the tertiary healthcare facilities are provided through big hospitals. These hospitals are mostly teaching hospitals and located in the major cities of Pakistan. In general, there are 39 teaching hospitals in public health sector of Pakistan.

The details about the region wise public healthcare facilities are given in the table 2.1. Healthcare sector mainly depends on human resources to efficiently deliver the services and the production of physicians has been increased as compared to other service providers especially nurses in Pakistan. Number of human recourses is provided in the table 2.2. The primary healthcare facilities are used by only less than 30 percent of the population and lack of healthcare professionals particularly, poor quality of services, high rates of absenteeism, and inconvenient location of PHC Units are the common reasons for underutilization of these units[27]. A significant proportion of population is covered by Pakistan Army, departments of local government, railways and autonomous organizations

Table 2.1 Region Wise Details of Public Healthcare Facilities

	Provinces / regions				
Type of health facility	National	Baluchistan	Khyber Pakhtunkhwa	Punjab	Sindh
Teaching hospitals	39	4	9	19	7
THQ hospitals	280	10	77	84	56
DHQ hospitals	108	27	21	34	11
Rural health centers	638	82	90	291	130
Basic health units	5798	549	822	2,454	774
Dispensaries	2312	575	307	499	643
MCH centers	1084	90	49	289	90
Sub-health centers	1207	24	30	443	15

Source: Health Facility Assessment – Pakistan National Report

These organizations provide healthcare to their employees on very low cost. The main source of financing in public sector is the government and these hospitals generate very low level of resources through Parchi charges (token fees).

[27] Health Systems Profile- Pakistan

Table 2.2 Manpower in Healthcare Facilities

Health Manpower	2011-2012	2015-2016
Registered Doctors	152,368	184,711
Registered Dentists	11,649	16,652
Registered Nurses	77,683	94,766
Population per Doctor	1,162	1,038
Population per Dentist	15,203	11,513
Population per bed	1,647	1,613

Source: Pakistan Economic Survey 2015-16

The fiscal and administrative space of provinces has become greater than before with instantaneous increase in their responsibilities but health workforce and facilities are still short relative to population. However, the inadequacies of public health sector on the one hand have increased the role of private sector and on the other hand the demand pull factors have given rise to the private healthcare provision (Pakistan Economic Survey 2015-2016).

2.2.2 Brief History of Healthcare System

At the time of independence Pakistan inherited a rudimentary healthcare system that was in the shape of some curative services and public health services. During 1947-1955, the initial problem was the replacement of staff. With the support of UNICEF, government initiated BCG vaccination campaign and two medical colleges were opened in the West Pakistan. All the development activities were planned for the period of five year after 1955 and it was known as Five Year Plan[28].

During 1^{st} Five Year Plan (1955-1960) postgraduate institutions were opened and a bureau was opened to produce vaccines. Six medical schools were established (one for women and five for men) in both sides. During 2^{nd} Five Year Plan (1960-1965) a malaria elimination program and

[28] History of healthcare system is taken from Health Systems Profile- Pakistan (Regional Health Systems Observatory-EMRO)

family planning program were launched. Two training institutes for health technicians were opened to cover 50000 populations each under a Medical Reform Commission.

During 3^{rd} five year plan (1965-1970) Small pox elimination programs and Tuberculosis Control Program were launched. In addition to the above mentioned programs, the large scale infrastructure of public healthcare was established in 1970's. Pakistan started the "health for all by 2000" initiative program which was launched by the World Health Organization (WHO). Government established a broad infrastructure and policy building initiative. Different healthcare programs were started from the villages to the cities e g "Basic health units" for the villages. The secondary healthcare includes Tehsil headquarter hospital and the tertiary care units include teaching and referral units and district hospitals. In addition to all above mentioned programs a substantial public health campaign was started, in order to meet the targets local needs and WHO guidelines were kept in mind. These programs include Malaria control program, a detailed program of immunization to eliminate the infectious diseases; Family planning program; Tuberculosis control program; Diarrhea and pneumonia control programs etc. National Institute of Health was established to observe all these programs and to attain improvements.

During 4^{th} five year plan (1970-1975), to control the prices of the medicines a generic name drug system was established and quota of medicines was significantly enhanced for big hospitals. Eight public fair price drug shops; six medical schools and three nursing schools; and one public health school were started. The 5^{th} five-year plan (1978-1983) was planned for 1975-1980, but a minor shift was shaped to make the plan more realistic. Country Health Program (CHP) aimed at upgrading the management and planning of healthcare services. It was suggested that rural health coverage be upsurge to at least 50 percent. During 6^{th} five-year plan (1983-1988), the government started broad rural development program that provided base for health by the year 2000.

The 7^{th} five year plan (1988-1993): afterwards the entire five years plans were based on the Alma Ata declaration (1978). During this plan Basic Health Units (BHUs) and Rural Health Centers (RHUs) were established, laboratory facilities were given along with health facilities and medical technician school was started. For improving MCH services, a project was launched and family health project was launched for improving the masses' health conditions. Under this plan there were some other salient initiatives like goiter and drug abuse control and formation of school of national health services. During 8^{th} five year plan (1993-1998), Social Action Program, Health Management Information System and Prime Minister Program for Primary Healthcare and Family Planning were started.

In 9^{th} five year plan (1998-2003) the main areas of programming was public private partnership, decentralized planning and imposing user charges for financing. The main aim of the plan was to monitor the gains achieved from the previous plans and to enhance the quality of services and removal of health system's weaknesses.

2.3 LITERATURE REVIEW

For past few decades, healthcare expenditures are rising rapidly in most of the countries; healthcare spending has not only increased in absolute terms but also in relative terms (relative to GDP). For example for the OECD (Organization for Economic Co-operation and Development) member countries, health expenditures (percentage of GDP) has increased dramatically from 9.2 percent in 1994 to 12.4 percent in 2013 and from 16.5 percent in 2013 to 12.8 percent in 1994 in North America (World Bank). There are many factors that can be responsible for this ever increasing trend, including epidemiologic transition, growing use of high cost technology, demographic change, institutional responses, sophisticated healthcare market and community expectations (Hajialiafzali, Moss et al. 2007). The upward increase in health expenditures highlights the importance of healthcare management of overall health system and particularly hospitals as most resources are consumed by hospitals (McKee and Healy 2002).

Although hospitals contribute to overall health status of the population, it also affects economic development due to reduction in morbidity/mortality and eventually reducing poverty (McCallion, Colin Glass et al. 2000). However, hospitals impose a financial burden on any nation as they consume a major share of healthcare expenditures. In developing countries, hospitals absorb 50 to 80 percent of public healthcare expenditures (Barnum and Kutzin 1993).

However, these expenditures are worth nothing if it leads to improvement in the overall population health conditions and enhances a nation's quality of life. In the literature of health economics, empirical studies on the efficiency measurement have focused on various parts of the healthcare system over the years. Mostly the focus has been on the healthcare system as a whole (macro level). These studies have used healthcare expenditures as input variable, unlike micro level studies. For output variables, life expectancy, maternal and infant mortality rates, child survival rates and disability adjusted life years (DALY) have been broadly used (Organization 2000, Afonso and St Aubyn 2004, Novignon 2015).

Another set of empirical studies have measured the efficiency at disease level. Basically, such studies estimate the efficiency of the resources used in the treatment and prevention of diseases. These studies analyze the efficiency within and across the countries (Baily, Garber et al. 1997, Garber and Skinner 2008). Such studies have used the inputs including human resources (physicians, nurses and other staff), physical capital (equipment and other facilities) and supplies (medications, surgical equipment etc.). The variables used as output were survival rate related to the treatment of each disease. Later the efficiency studies are micro based and evaluate efficiency at the hospital level using hospital human resource (physicians, nurses and other staff), physical capital (hospital beds) as inputs and inpatient and outpatient days as health outputs (Grosskopf and Valdmanis 1987, Ozcan 1992, Burgess Jr and Wilson 1998, Grosskopf, Margaritis et al. 2004, Ferrier, Rosko et al. 2006)

Over the past three decades, the efficiency measurement of public and private health organizations is the most explored area of research and many studies have documented that most of healthcare providers do not always utilize the resources efficiently (Carrington, Puthucheary et al. 1997). The efficiency measurement by observing the performance of each unit and comparing it with each other, is a worthwhile tool for vindicating resource allocation, for improvement towards health management and mobilizing inputs. So, the researchers being convinced with this evidence have conducted many studies related to the efficiency measurement of the overall healthcare system in general and hospitals in particular over the previous few years.

Empirical studies regarding the efficiency measurement of the public and private hospitals can be found in literature but these studies are mostly from developed countries. In the US, (Sherman 1984) first estimated the technical efficiency of seven US teaching hospitals by using Data Envelopment Analysis (DEA). After Sherman (1984), many researchers have estimated the technical and allocative efficiency of the US hospitals like (Bannick and Ozcan 1995) have estimated the performance of federally funded hospitals using DEA. Other examples from US are (Grosskopf and Valdmanis 1987, Ozcan 1992, Burgess Jr and Wilson 1998, Grosskopf, Margaritis et al. 2004, Ferrier, Rosko et al. 2006).

Until 1994, no studies appeared to relate European hospitals and first European study was conducted by Fare et al (1994). He went on to estimate the productivity development in Swedish hospitals using Malmquist output index approach in DEA. Other studies related to European hospitals are (Mobley IV and Magnussen 1998, Athanassopoulos, Gounaris et al. 1999, Sahin and Ozcan 2000, Athanassopoulos and Gounaris 2001) etc. After 1997 a number of studies from other countries including Canada, Kenya, Taiwan, and Turkey have appeared. Examples from UK are (Parkin and Hollingsworth 1997, Maniadakis and Thanassoulis 2000, McCallion, Colin Glass et al. 2000).

The choice of methodologies used to measure efficiency is a controversial issue. In the parametric techniques, there is a variety of production processes which makes it difficult to evaluate efficiency and mostly researchers prefer to use non-parametric techniques (Pina and Torres 1996, Pilyavsky and Staat 2008). There are two widely used methods to measure the efficiency of healthcare units: stochastic frontier analysis (SFA), based on regression techniques, and data envelopment analysis (DEA), based on linear programming (O'Neill, Rauner et al. 2008). Every method has its own strengths and weaknesses, but both provide comparable results (Nayar and Ozcan 2008).

According to Garcia-Lacalle and Martin (2010), efficiency can hardly be reflected as the final outcome of healthcare providers and further improvement is required to achieve the organizational objectives. Most of the efficiency studies focus on the volume of the therapeutic and diagnostic services. Very little attention has been given to the quality of care, population, staff and other hospital functions that affect patients' preferences. However, studies may produce misleading results by not addressing all the functions of hospital and quality of care. To increase the validity of the results, the analysis should be done with careful understanding of full range of hospital functions including the perspectives of patients, staff and community (Hollingsworth 2003). Few empirical studies have recognized the importance of quality adjusted output and investigated the relationship between efficiency and quality but have mixed findings. For instance, some researchers found negative relationship between quality and operational efficiency of the hospitals (Morey, Fine et al. 1992, Maniadakis, Hollingsworth et al. 1999). While others established a positive association (Clement, Valdmanis et al. 2008, Nayar and Ozcan 2008). (Clement, Valdmanis et al. 2008) used DEA to study the efficiency of 667 American hospitals and included multiple quality indicators as output and concluded that poor technical efficiency is associated with lower quality adjusted outcomes. (Nayar and Ozcan 2008) used DEA to examine the performance of Virginia hospitals and related the measure of quality to technical efficiency. They concluded that more technical efficiency is related with higher perceived quality.

Valdmanis, Kumanarayake et al. (2004) applied DEA to 1377 urban hospitals including nurse-sensitive measures of quality and concluded that higher quality need not to achieve with a higher cost. Whereas, (Navarro-Espigares and Torres 2011) analyzed the efficiency and quality evolution in Andalusian Hospitals during the time period 1997–2004 and concluded that the efficiency–quality trade-off does not exist.

However, these studies mainly focus on developed countries and their results are inconclusive. Healthcare system of developed countries is incomparable to developing countries, due to various challenges[29] that the latter face. There are very few studies that address the performance and quality measurement of hospitals in less developed countries. To the best of my knowledge, not a single study has explored the relationship between quality and efficiency of Pakistan's public hospitals. Thus, given the social-demographic realities and macroeconomic conditions of Pakistan, there is an urgent need to estimate the efficiency of public hospitals and evaluate the relationship between efficiency and quality indicators.

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[29] Scare resources, high population growth rate, an insistently high neonatal mortality rate, and high maternal and infant mortality rates etc.

2.4 THEORETICAL FRAMEWORK

The section of theoretical framework contains three subsections. The first present the model for the relationship between technical efficiency and objective quality. The theoretical background for two stage residual inclusion is presented in the second subsection. The last subsection comprises the theoretical framework for efficiency measurement.

2.4.1 Relationship between Efficiency and Quality

The hospital industry (profit and non-profit hospitals) has been ignored by economic theory during the past century and a half, but recently it has grown in importance (Newhouse 1970). As this study is concerned with the relationship of hospital status and economic efficiency, the postulation of a maximization problem of a hospital is necessary to understand the relationship; for-Profit (FP) and Not-For-Profit (NFP) hospitals behave differently. Traditional FP hospitals maximize profit given resource and quality constraint, whereas NFP hospitals maximize prestige (defined as the weighted average of quantity and quality of healthcare). Generally, prestige maximization lies at the middle of the spectrum between pure altruism and profit maximization (Brewster, To et al. 2010). Long (1964) was the first to propose the theory of nonprofit hospitals and suggested that hospitals maximize the number of patients served (quantity) subject to quality and budget constraints.

Newhouse (1970) has built a model of hospital to explicitly integrate quality into the objective function. He assumed that nonprofit hospitals jointly maximize quality and quantity subject to a resource constraint. The hospital chooses the maximum possible quantity for each level of quality, given a condition of zero-profit. To achieve a highest possible level of utility, a hospital chooses a combination of quantity-quality and still leads to the least costly bundle for production. In particular, nonprofit hospitals are less likely to provide higher quality services compared to for-profit hospitals.

According to (Chang and Jacobson 2011) all hospitals maximize the following objective function:

$$V = R + f(P; q; \theta; u)$$

Where R is net revenue of a given hospital, q is the provided healthcare, P represents non-distortionary perquisites, θ is “anything that increases the cost of production, such as non-contractible quality" or distortionary perquisites, and u represents the level of free care provided by a given hospital. This objective function is maximized subject to the following constraint:

$$\pi(q, \theta) - R - P - u - F \geq 0$$

$$\pi(q, \theta) = pq - C(q, \theta) = \int_0^q p - (C(x) + \theta)dx$$

Where F is the fixed cost, p represents price and “C are continuous functions which are weakly increasing and weakly convex in their arguments. All the hospitals, for instance, For-Profit (FP), Not-For-Profit (NFP) and government owned healthcare units maximize V subject to the above stated constraints choosing different values for q, P, θ and u. These hospitals must at least break even. The current study will consider q as technical efficiency (instead of quantity as used in the original model) whereas θ will still represent quality. We argue that efficiency and quality may not always be the same thing. Specifically, technical efficiency only talks about maximization of output with the given amount of inputs and does not incorporate quality of the output. Hence, a hospital may be efficient and a low-quality service provider at the same time. Subsequently, the objective function of a given hospital depends on both, efficiency and quality besides other variables.

Following the work of Newhouse (1970), this study assumed that the public and private hospitals integrate the quality and efficiency into their objective function. All the public and private hospitals maximize V given resource constraint by choosing different values of q, P, θ and u. This study is interested to examine the relationship between efficiency and quality (q &θ). Hence, theoretically speaking, there can be three possible relationships between these two variables:

$$\frac{\partial \theta}{\partial q} \lesseqgtr 0$$

That is, an increase in efficiency of a hospital can increase or decrease the quality of its services. In addition, it is also possible that the quality of health service is independent of the level of technical efficiency. There can be possibility of other way round. Hospitals may have economic pressure to increase their efficiency at the cost of lower quality.

$$\frac{\partial q}{\partial \theta} \lesseqgtr 0$$

So, due to simultaneity between an explanatory variable and the outcome, endogeniety arises. Which of this relationship holds for the healthcare units in Pakistan is an empirical question, which this study aims to answer.

2.4.2 Two-Stage Residual Inclusion (2SRI)

Most of the applied economic fields rely on the observational data. So, endogeniety is a common problem in these fields including health economics. Endogeniety arises due to some factors such as omitted variable bias, simultaneity between the outcome and the explanatory variable and errors in covariates. To control endogeniety of predictors, Instrumental variables (IV) methods are commonly used in the literature. Most of the theoretical and empirical literature use IV methods for linear regression models to control endogeniety. Whereas, in recent health economics literature nonlinear models are widely used such as count data, limited dependent variable etc. However, the 2SLS, 2SPS and 2SRI approaches continue to produce similar results as long as the regression models are linear (Basu and Coe 2015).

Terza, Basu et al. (2008) addressed the confusion between the uses of IV methods in nonlinear regression models. They have compared 2SRI approach with 2SPS (Two stage predictor substitution) approach and concluded that former produces consistent estimates.

Two Stage Predictor Substitution (2SPS) approach is considered as an extension to nonlinear regression models of the linear 2SLS (Two stage least square). An auxiliary regression is estimated at the first stage of 2SPS and then predicted values are estimated using the results of first stage. At second stage, the outcome equation is regressed by replacing the predicted values in place of original endogenous variable. Whereas, the first stage of 2SRI is similar as of 2SPS. In second stage estimation, residual of the first stage equation is included as an additional explanatory variable. Hausman (1978) suggested this approach first in linear context.

We have employed nonlinear modeling framework following (Terza, Basu et al. 2008),

$$y = F(x_e\beta_e + x_o\beta_o + x_u\beta_u) + e$$

$$y = F(X;\beta) + e$$

$$e = y - F(X;\beta) \qquad \text{So} \qquad E(e/X) = 0$$

Where e is the random error and F (·) is a known nonlinear function, and we have three types of regressor, x_e is the vector of endogenous regressor, x_o is vector of observable exogenous regressor and x_u is the vector of unobservable confounders. The auxiliary regression is,

$$x_u = r(W;\alpha) + \ x_u$$

Where $W = [\,X_o \;\; W^+]$ and $W^+$is the vector of identifying IVs. At first stage the residuals are obtained applying nonlinear regression models,

$$\widehat{x_u} = x_e - r(W;\hat{\alpha})$$

Where $\hat{\alpha}$ is the first stage estimates of α and consistent estimates of β are obtained by applying nonlinear regression model to the following equation.

$$y = F(x_e, x_o, \widehat{x_u}; \beta) + e^{2SRI}$$

Where e^{2SRI} is the residual obtained in first stage regression and it's not necessary nonlinear regression be applied in either or both stage equations. For instance, Maximum likelihood method can be used in either or both stages of the 2SRI.

2.4.3 Theoretical Background of Efficiency Measurement

Efficiency is measured by examining the relationship between a given output (product of the healthcare system) and its related inputs (the resources used to produce that output). A provider is considered efficient if it is able to minimize inputs in order to produce a given amount of output and to maximize output for a given set of inputs (Koopmans 1951).

Farrell (1957) explained the concept 'measures of efficiency' and divided efficiency into two constituents. The first is technical efficiency and the second one is allocative efficiency (Hollingsworth and Peacock 1999). Productive efficiency or economic efficiency is determined by combining the concept of allocative efficiency and technical efficiency (O'Neill, Rauner et al. 2008). Allocative efficiency is circumscribing the concept of technical efficiency. The allocative efficiency requires the information related to the relative prices of inputs and outputs. A firm is allocative efficient if it maximizes profit for a given cost or minimizes cost to produce a given level of output. Whereas, technical efficiency has nothing to do with profit maximization or cost minimization. A firm is said to be technically efficient if it produces the maximum output for a given level of inputs or employed the minimum resources to produce a fixed level of output (Farrell 1957).

The concept of technical efficiency in production was first developed by Farrell (1957) and was further technologically advanced by (Boles 1966, Charnes, Cooper et al. 1978, Färe and Lovell 1978). Scale efficiency is a component of technical efficiency. Constant returns to scale – the long-run outcome among competitive firms – signify perfect scale efficiency. If a firm is operating at either increasing or decreasing returns to scale, it is not scale efficient (Salerno 2003). If a firm's scale of operations is too large or too small, it is operating at decreasing returns to scale or increasing return to scale. In both cases, the firm should modify the size of operations to become scale efficient (Coelli, Rao et al. 2005).

Farrell (1957) estimated a frontier against which the performance of DMU can be compared in order to measure technical efficiency. Following his pioneer work, many researchers tried different techniques to compute efficiencies. Broadly, these techniques can be divided in two major groups: parametric techniques, and non-parametric techniques.

The most commonly used parametric techniques are the thick frontier approach (TFA), the stochastic frontier analysis (SFA), and the distribution-free approach (DFA), whereas, free disposable hull (FDH) and data envelopment analysis (DEA) are among the widely used non-parametric techniques. Over 50 years, the frontiers for efficiency measurement in different fields have been estimated. The two principle methods which are most widely used in the literature are Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA).

Data envelopment analysis (DEA) was first described by (Charnes, Clark et al. 1984) and basically a non-parametric and linear programming technique used for measuring the performance of DMUs in the presence of multiple inputs and outputs. Originally (Farrell 1957) proposed a piecewise-linear convex hull approach for frontier estimation, but was unable to get popularity until (Charnes, Cooper et al. 1978) formulated this approach into a mathematical programming.

They considered input-oriented, constant returns to scale (CRS) specification, a variable returns to scale (VRS) model (Banker, Charnes et al. 1984) and an output-oriented model are the further modifications of this methodology.

Aigner, Lovell et al. (1977), Battese and Corra (1977), Meeusen and van Den Broeck (1977) proposed the method of Stochastic Frontier Analysis (SFA) based on Farrell's approach. SFA is a parametric and stochastic technique of performance measurement and is based on the idea that a frontier represents the maximum output possible, given a set of inputs. These techniques are based on econometric regression models. Mostly production, profit, or cost frontier is used, and efficiencies are computed relative to that frontier. SFA requires a functional form, and it also allows for the random disturbances in the model.

A number of studies conducted not only to extend both the methods e.g. SFA algorithm (Kumbhakar and Lovell 2003) and DEA algorithms (Cooper, Seiford et al. 2004) but also to measure efficiency for a wide range of goods and services because of the significance of efficiency measurement for both developing and developed countries. Several research studies in numerous fields occurred because of the practical use of these techniques for the estimation of efficiency. With these considerations, to measure the efficiency score of the health facilities this study will use two most widely used techniques, one non-parametric and one parametric technique viz. Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA).

2.4.3.1 Frontier fundamentals

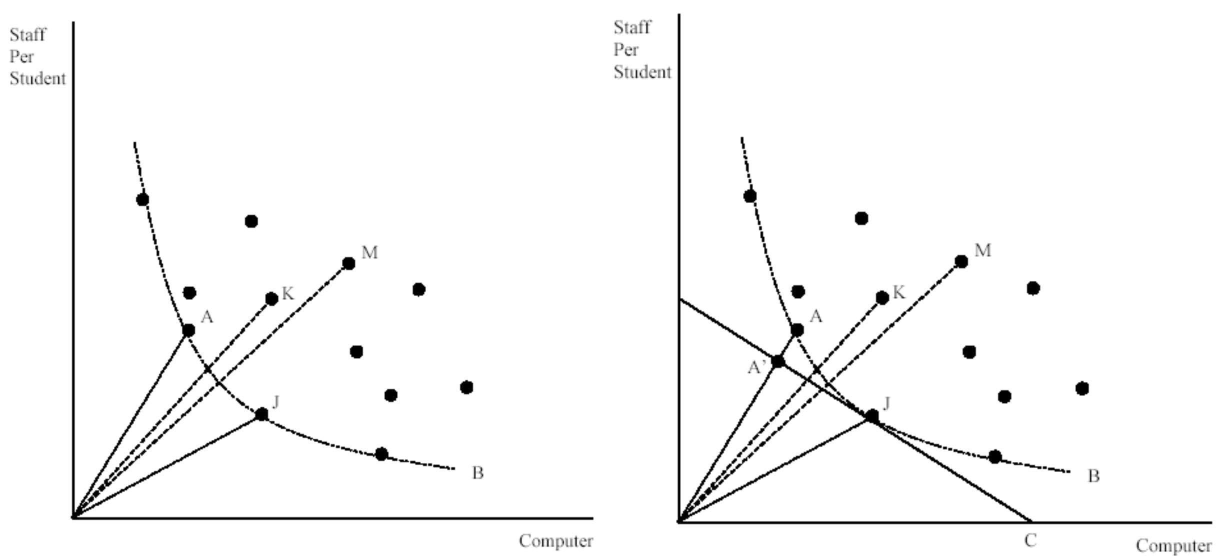
Production possibilities frontiers are usually studied in economics. All points on a production possibilities frontier curve represent the "maximum output attainable from each input level" (Coelli, Rao et al. 2005).

There are different measures of efficiency. Farrell (1957) divided the concept of efficiency into two main components, technical and allocative efficiency (Hollingsworth and Peacock 1999). Technical efficiency is achieving maximum output given a set of inputs or to consume minimum inputs given a level of output. Technical efficiency does not imply cost minimization or benefit maximization, because costs are not considered. Allocative efficiency involves production decisions given prices/cost (Salerno 2003).

The difference between the concept of technical and allocative efficiency can be seen in the following diagram. The given diagram represents the possible combinations of two inputs (staff and computers) to produce output (educational achievement in this case).

Figure 2.1 Technical and Allocative efficiencies

a)Technical **b) Allocative**



Source: (Salerno 2003)

Diagram (a) consider only technical efficiency and points **A** and **J** are considered technically efficient because both the points lie on the frontier represented by Isoquant **B**. Diagram (b) includes Isocost line C, point J which is located at the point of tangency; it is both technically and allocative efficient. On the other hand point A is technically efficient but not allocatively efficient. Cost efficiency is the product of allocative and technical efficiency (the ratio of the line segment from the origin to the Iso-cost line to the line segment from the origin to the actual point). These concepts are pertinent to revenues and outputs with respect to the frontier as well (Coelli, Rao et al. 2005).

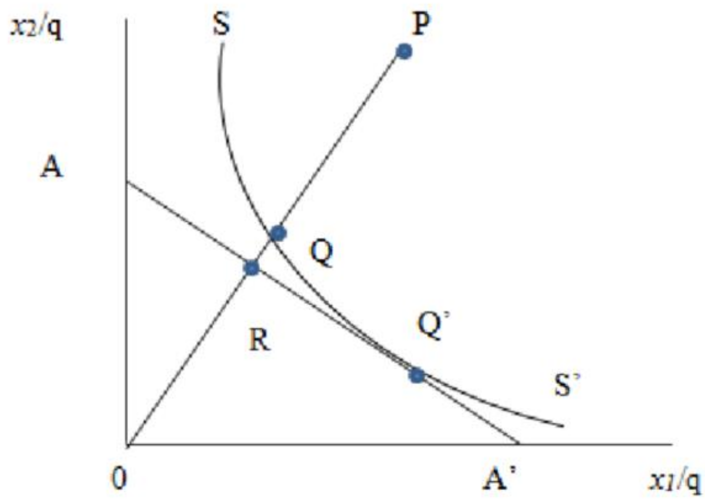
Debreu (1951) and Farrell (1957) defined technical efficiency as "*one minus the maximum equal proportionate reduction in all inputs that still allows continued production of given outputs (or alternatively, equal proportionate expansion in outputs with given inputs)".* If the hospital is technically efficient, the attained score will be unity and a score of less than unity would show the degree of austerity of technical inefficiency.

2.4.3.2 Input Oriented Measures of Efficiency

Input oriented technical efficiency is the measurement related to the following query. By how much the input quantity can be reduced without decreasing the given produced output? Farrell (1957) described the concept using a simple example of a firm which used two inputs (x_1 and x_2) and to produce an output (Malmquist) under the assumption of constant return to scale[30] (CRS). SS' represents the Isoquant of fully efficient firm in figure.3 and a firm uses quantities of inputs represented by point P to produce a given level of output (Malmquist).

[30] The constant return to scale technology allows using a unit Isoquant.

Figure 2.2 Explanation of Technical and Allocative Efficiency



The distance QP represents the technical inefficiency of that firm and this is the amount by which all the inputs can be decreased without a reduction in output level. This can be expressed by the ratio QP/OP in percentage terms (this is the percentage by which all the inputs can be decreased). The technical efficiency (TE) is widely measured by ratio,

$$TE^{I}$$ [31]= OQ/OP

The Iso-cost line (input price ratio) is represented by the line AA' in figure 3 and a firm uses quantities of inputs represented by point P to produce a given level of output (Malmquist). The allocative efficiency of that firm is computed by a ratio,

$$AE^{I} = OR/OQ$$

[31] The superscript I is used to show that the technology is input oriented

Production costs will be reduced if the production occurred at the efficient (technically and allocative) point Q'which is represented by the distance RQ. So, the economic efficiency which is the combination of technical and allocative efficiency is measured by the ratio,

$$EE^I = OR/OP$$

Where the distance RP represent the overall cost reduction and the note that the overall economic efficiency is the product of technical and allocative efficiency[32],

$$EE^I = TE^I \times AE^I = OQ/OP \times OR/OQ = OR/OP$$

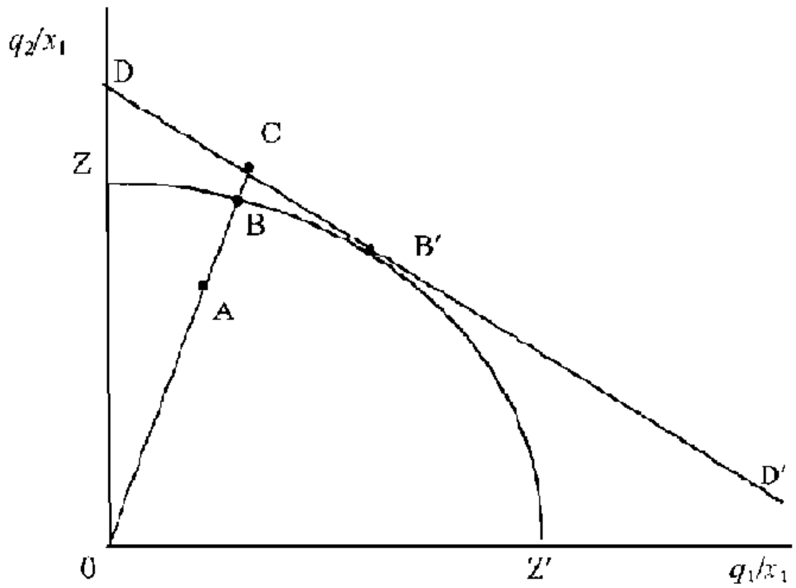
2.4.3.3 Output Oriented Measures of Efficiency

Output oriented technical efficiency is the measurement related to the following query; given a certain level of inputs, how much of the output can potentially be maximized. Farrell (1957) explained the concept of output-oriented measures of efficiency by taking an example of a firm which produced two outputs (q_1 and q_2) with one input (x_1). The technology can be represented by unit production frontier in two dimensions when we take the assumption of constant return to scale.

In the figure below the unit possibility curve is represented by the line ZZ' and an inefficient firm is denoted by point A. Note that this inefficient point lies below the frontier where the production possibility frontier is the upper bound.

[32] The value of all the three measures (economic, technical and allocative) lies between 0 and 1.

Figure 2.3 Allocative and Technical Efficiency (Output Oriented)



Source: (Coelli 1996)

Farrell (1957) describe the distance AB as technical inefficiency (the amount by which the output could expand without increasing inputs). The output oriented technical efficiency (TE) is widely measured by ratio,

$$TE^{O}\text{[33]} = \text{OA/OB}$$

We can draw the ISO-cost line based on which allocative efficiency can be calculated if we have information related to the prices of inputs and outputs. Allocative efficiency can be measured by the following ratio,

$$AE^{O} = \text{OB/OC}$$

The overall economic efficiency which is the combination of technical and allocative efficiency is measured by the ratio,

$$EE^{O} = TE^{O} \times AE^{O} = \text{OA/OB} \times \text{OB/OC} = \text{OA/OC}$$

[33] The superscript O is used to show that the technology is output oriented

Furthermore, the economic efficiency can be defined as the product of technical and allocative efficiency[34]. All these efficiency measures are input and output oriented, and both are also called Radial Measures as they measure along the ray from origin to the actual observations. It means these measures are time invariant (value of efficiency measure will not change if we change the measurement units). Input and output oriented measures of technical efficiency are equal to the input and output distance functions described by Shepherd (1970) and Malmquist (1953) introduced the distance functions. "A distance function[35] is the distance between elements of a set with some nice mathematical properties".

2.4.3.4 Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric linear programming technique developed by Charnes, Cooper et al. (1978) based on the ideas of Farrell (1957) for the estimation of "best-practice frontier" and it is also known as CCR ratio named after its creators O'Neill, Rauner et al. (2008). This CCR model was based on the assumption of constant return to scale and it was input oriented. Färe, Grosskopf et al. (1983) and Banker, Charnes et al. (1984) proposed the models with variables return to scale by imposing the convexity constraint.

DEA is used for the measurement of productive efficiency of decision making units (DMUs) which have same objectives and goals. This technique possess certain advantages; there is no need to aggregate data into meaningless indices as DEA allows multiple inputs and outputs in the analysis (Hollingsworth and Peacock 2008). DEA provides both the amount of inefficiency and associated sources that is, it identifies the source of inefficiencies and the inefficiency score as well. It is non-parametric and hence no assumptions are required on the functional form of the

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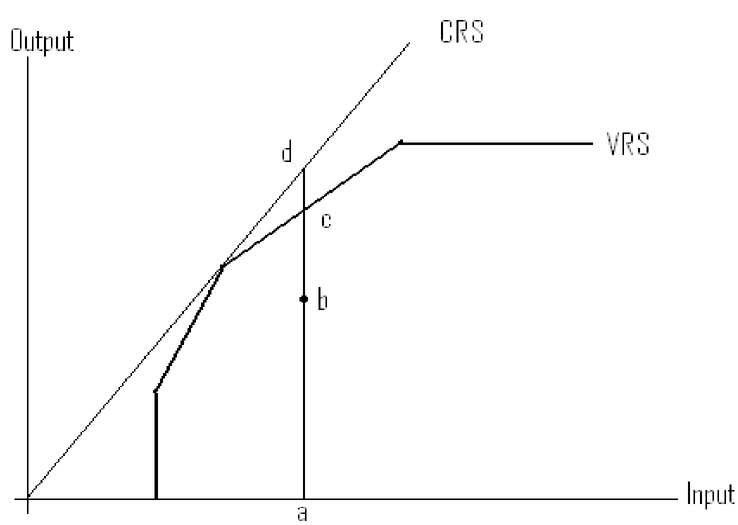
[34] Again the value of all the three measures lies between 0 and 1

[35] For more detailed on distance functions see shepherd (1970), Fare and Lovell (1978), and Lovell (1993, p10) and the concept of distance functions is very important when one is using DEA in estimating Malmquist indices for total factor productivity change.

relationship between outputs and inputs. It also means that efficiency is estimated only from the sample observations themselves; however, it can be very sensitive to data outliers within the sample. In general, DEA cannot discriminate among efficient DMUs because all the efficient entities obtain unit score (Jacobs 2001). However, some researchers developed a concept of "super-efficiency" that differentiates between the efficient DMUs. Super-efficiency technique estimates the reference frontier (excluding data for the i^{th} entity). The program runs various times and the i^{th} entity becomes more efficient than the frontier (Coelli, Rao et al. 2005).

DEA can be used employing either of the two approaches (output-oriented approach or input-oriented approach). If constant returns to scale technology are assumed, then the efficiency scores will be same from both the approaches, but the scores would be different under the assumption of variable returns to scale (Coelli at al 2005, pp. 180). Moreover, "*Output- and input-oriented DEA will estimate exactly the same frontier and therefore, by definition, identify the same set of firms as being efficient. It is only the efficiency measures associated with the inefficient firms that may differ between the two methods*" (Coelli, Rao et al. 2005).

Figure 2.4: Production Frontier under the assumption of CRS and VRS



Production frontiers (optimal combinations of inputs and outputs) are presented in the above figure with the assumption of constant returns to scale and variable returns to scale. If a DMU is producing at point "b" then the technical efficiency under the assumption *CRS* is ab/ad. Whereas the technical efficiency under the assumption *VRS* is ab/ac and the efficiency score under VRS model is higher than CRS because it fits data, more tightly.

It is supposed that there are n health-providing units ($i = 1,2, \ldots \ldots, n$) producing unit output, using m inputs ($j = 1,2, \ldots \ldots., m$). Furthermore, it is assumed that $y_i \geq 0$ and $x_{ij} \geq 0$ means each unit produces positive level of output and each unit utilizes at least one positive input. The DEA can be better introduced via the ratio form and a measure of the ratio of all outputs over all inputs would be obtain for each DMU (uy_i/vx_i), where u is the vector of output's weights and v is the vector of input's weights. The considered DMU is represented by i. The following mathematical programming problem is to select the optimal weights,

$$Max_{uv} \; uy_i/vx_i$$

$$\text{s.t.} \quad uy_i/vx_i \leq 1 \qquad\qquad i = (1,2, \ldots \ldots, n)$$

$$u, v \geq 0$$

Where $u \; and \; v$ are the vectors of weight for outputs and inputs, with a constraint that the weights cannot be negative and subsequently the inputs and outputs cannot be negative. The weights for outputs and inputs are computed in this way that the efficiency of the considered unit $\boldsymbol{i}$ will be maximized. If we take any other values for $u \; and \; v$ the efficiency score will become smaller. The above stated mathematical programming problem has one concern, that it has infinite number of solutions. This can be solved, if we impose a constraint, $\boldsymbol{vx_i = 1}$ which provides,

$$Max_{\mu v} \; \mu y_i$$

$$vx_i = 1$$

$$\text{s.t.} \quad \mu y_i - v x_i \leq 0 \qquad i = (1,2,\ldots\ldots,n)$$

$$\mu, v \geq 0$$

The transformation is reflected by changing the notation of weights from u, v to μ , v. This is called the Multiplier form of the linear programming model. One can convert the above stated problem into the envelopment form, by using the duality property of linear programming.

$$Min_{\Theta\lambda} \ \Theta$$

$$-y_i + Y\lambda \geq 0$$

$$\Theta x_i - X\lambda \geq 0$$

$$\lambda \geq 0$$

Where **λ** is the vector of constants and Θ is a scalar. This envelopment form is most preferred because it involves less constraint than the multiplier form. The efficiency score will be obtained from the value of Θ for i^{th} DMU and the value of Θ must satisfy this constraint $\Theta \leq 1$. If the value of Θ is equal to 1 indicating this point lies on the frontier and it will be a technical efficient DMU. The above model is with the assumption of CRS and if we incorporate one constraint $e'\lambda = 1$ then the model will become VRS model.

2.4.3.5 Stochastic Frontier Analysis

Aigner, Lovell et al. (1977) and Meeusen and van Den Broeck (1977) introduced the concept of Stochastic Frontier Analysis (SFA). SFA technique estimates a production function frontier which represents the maximum output given inputs. Subsequently, the frontier represents an upper bound of outputs and the distance from the frontier represents the inefficiency error which is one-sided. It allows the possibility of random error as SFA is stochastic and it is a parametric technique means it requires the functional form (linear, log-linear, Cobb-Douglas, Translog etc.). One major drawback of SFA is, that it does not allow multiple outputs.

It divides the traditional error term into two parts; random error and inefficiency. The later one is assumed to be strictly positive and usually a half normal distribution. "The $\boldsymbol{v_i}'\boldsymbol{s}$ [stochastic variability of the frontier] is assumed to be independently and identically distributed normal random variables with zero means and variances σ_v^2" (Coelli, Rao et al. 2005). SFA investigations start with a defined process, in general form

$$y_i = \mathrm{f}\,(x_1, x_2, \dots \dots x_n, \beta) + \mathrm{v}_i - \mathrm{u}_i \qquad i = 1, \dots\dots, I$$

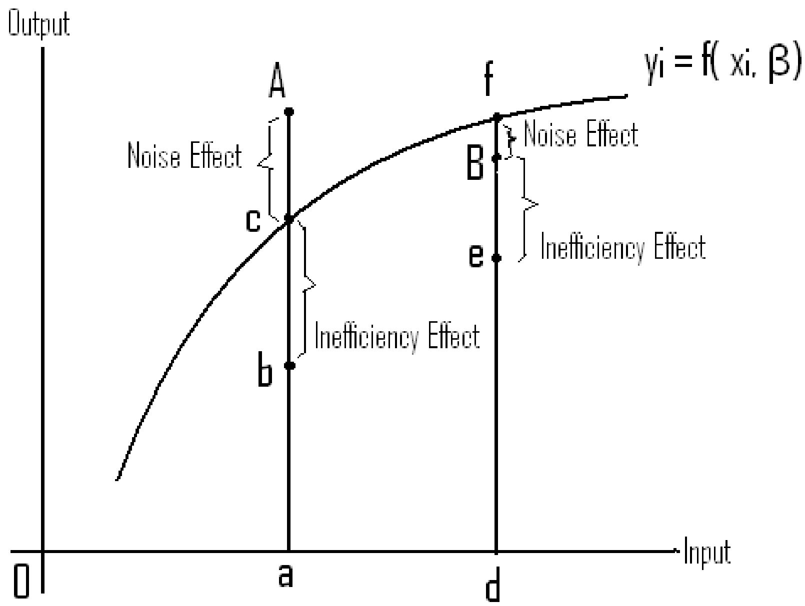
Where y_i is the scaler output of the unit, x_i is the vector of inputs, f (x_i, β) is the production function, β is the vector of technology parameters, v_i is the usual random error term and u_i is the error term which shows technical inefficiency.

The production function f (.) requires algebraic form grounded on economic theory and production function forms are categorized by some properties. A flexible functional form normally uses quadratic terms that are attained from second-order series expansions. A parsimonious functional form reveals the simplest function and it means that inclusion of more parameters would cause statistically insignificant expansions in sums of squared errors or whatever criterion is used. Achieving all of these properties (concavity, monotonicity, non-negative output and presence of at least one input) is difficult at a similar time. "Simultaneous imposition of both of these conditions [curvature and monotonicity] on a parsimonious flexible functional form destroys the model's local flexibility property" (Barnett and Usui 2007).

Over time, a number of production functions have become common to use. These comprise the translog, quadratic, normalized quadratic, constant elasticity of substitution (Berta, Martini et al.) and generalized Leontief. In the research of healthcare efficiency, the two functional forms that are used most commonly are Cobb-Douglas and Translog. Christensen, Jorgenson et al. (1971)

proposed the transcendental logarithmic (Translog) model by employing Taylor series expansions in logarithms (Barnett and Usui 2007), which has both linear and quadratic terms. The Cobb-Douglas function is a special case of the translog function, where the parameters of cross products and squared terms are assumed to be zero. So, the translog function is more flexible than the Cobb-Douglas function. For graphical explanation of the stochastic production frontier, the figure is given below,

Figure 2.5 Stochastic production frontier



The curve in the above figure shows the deterministic part of the stochastic production frontier and the actual units of production are points A and B in the figure. The random error is positive for unit A, while for unit B the random error is negative. Technical efficiency of the DMU A will be ab/aA and for B, it will be de/eb.

We cannot use Ordinary Least Square for the estimation of above mentioned model because OLS provides consistent estimates for slope parameters but not for the intercepts (Kumbhakar and Lovell 2003). The consistent results can be obtained by applying Maximum Likelihood estimation technique for efficiency score as well as for parameter estimates. The obtained results of technical efficiency are as a mean of the conditional distribution of $\boldsymbol{u_i}$ given$\boldsymbol{\varepsilon_i}$, where $\varepsilon_i = u_i + v_i$ (Kumbhakar and Lovell 2000, pp. 82).

Coelli (1996) used a one-sided likelihood ratio test to check the significance of the estimated inefficiencies with chi-square distribution ($\chi^2 = \frac{1}{2}\chi_0^2 + \frac{1}{2}\chi_1^2$), to test the null hypothesis that there is no inefficiency against the alternative that the inefficiency exists.

If LR $> \chi^2$, the null hypothesis will be rejected. When the score of technical efficiency obtained the mean efficiency score of two groups can be compared by using t – statistics,

$$t = (x_1^- + x_2^-) / \sqrt{[s_p^2 / n_1 + s_p^2 / n_2]}$$

Where x_1^- and x_2^- are the mean efficiency score of two groups, s_1^2 and s_2^2 are the variances of mean efficiency score of both the groups, n_1 *and* n_2 are the number of the decision making units in each group and s_p^2 is the pooled variance of both the groups and it is estimated by following formula,

$$s_p^2 = \{ (n_1 - 1) s_1^2 + (n_2 - 1) s_2^2 \} / (n_1 + n_2 - 2)$$

2.5 DATA, VARIABLES AND ECONOMETRIC METHODOLOGY

This section is divided into two subsections. First contains the details related to data and variables used in this chapter. The empirical methodology is described in the second subsection.

2.5.1 Data and Variables

In order to measure the efficiency of public hospitals, data from Health Facility Assessment (HFA) survey, which is part of the Newborn, Maternal and Child Health Programme (NMCHP) has been used. NMCHP was established by the Ministry of Health in Pakistan with the goal to improve the maternal health outcomes and assist with the achievement of the Millennium Development Goals (MDGs). Its aim was to discover the gaps between the required and actual level of resources available at hospitals, including staff, infrastructure, equipment, drugs and supplies. The survey was conducted between October 2010 to May 2011, with design and implementation support from Technical Resource Facility (TRF)[36] across Pakistan and was additionally funded by DFID[37] and AusAID[38].

The survey included 2,018 hospitals, of which 108 are district headquarters (DHQs)[39], 208 Tehsil headquarters (THQs)[40] and civil hospitals, 638 rural health centers (RHCs)[41] and 992 sampled basic health units. Maternal and newborn health services are provided only in secondary hospitals (district and sub-district headquarters) and RHCs from four provinces in Pakistan, and thus only those (843) are retained in our sample.

Data provides information on resources used by the hospitals, such as medical specialists, Women Medical Officer (WMO), nurses, technical and other staff. In order to calculate efficiency, we use ratios, where available resources are divided by the required resources (based on district

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[36] TRF focuses on the capacity building and technical assistance in the sector of nutrition and health. It supports the government over six years to improve maternal, neonatal and child health through capacity development in the areas of health policy and service delivery.

[37] Department of International Development is the UK's efforts to tackle global development challenges and end extreme poverty in Pakistan. DFID works with other organizations to support Pakistan e.g. World Bank, Asian Development Bank, United Nation Agencies, British Counsel and national and international NGOs.

[38] AusAID is Australia's aid program to Pakistan. Australian government supports Pakistan for promoting equitable and sustainable development.

[39] DHQ hospitals are secondary healthcare hospitals and located at district headquarter level. They serve almost 1 to 3 million population and provide advance diagnostic, preventive, promotive, curative, referral, advance specialist and inpatient services along with basic and emergency obstetric and newborn care.

[40] THQ hospitals are also secondary healthcare hospitals located at tehsil headquarters level. They serve about 0.5 to 1.0 million population and contain almost 40 to 60 beds. They provide diagnostic, preventive, curative, inpatients, referral and specialist services as well as basic and emergency obstetric and newborn care.

[41] RHCs are primary healthcare hospitals and a hospital serves up to 10,000 people. A RHC contains almost 10 to 20 beds. It provides diagnostic, curative, preventive, promotive, referral and inpatient services except specialized services as the secondary healthcare hospitals offer.

reports HFA). Complete list of variables used as inputs and outputs for the efficiency measurement is presented in the Table 2.3.

For performance evaluation of obstetric services, the total number of deliveries (includes both vaginal births and cesarean section) are used as output. Medical specialists, WMOs, nurses, technical and other staff are used as inputs. The variables which have been selected as control variables at hospital level are the availability of gynecologist residence, anesthetist residence, pediatrician residence, WMO residence, ratio equipment, ratio medicines, ratio specialists, ratio WMO, and ratio ambulance. The district level selected control variables are HDI, literacy rate and population for the analysis of the association between efficiency and quality measure in case of public hospitals from the same data set.

Table 2.3 Descriptive Statistics of Variables used in the Analysis

Variables	Number of hospitals reporting	Minimum	Maximum	Mean	Std. Deviation
Output					
Deliveries	843	12	31452	572.83	1553.14
Inputs					
Specialists	843	1	11	1.58	1.37
WMO	843	1	29	2.5	2.27
Nurses	843	1	159	6.49	11.82
Other Staff	843	1	29	5.59	3.6
Technical Staff	843	0	24	1.48	2.52
Control Variables					
Gynecologist Residence	843	0	1	0.09	0.28
Anesthetist Residence	843	0	1	0.04	0.2
Pediatrician Residence	843	0	1	0.08	0.27
WMO Residence	843	0	1	0.63	0.48
Ratio Equipment	843	0.03	0.96	0.53	0.18
Ratio Medicines	841	0	1.03	0.63	0.19
Ratio Specialists	843	0	3	0.14	0.33
Ratio WMO	843	0	6.5	0.49	0.61
Ratio Ambulance	843	0	2.5	0.82	0.34
HDI	100	0.225	0.67	0.48	0.08
Literacy Rate	100	9	81	50.69	12.7
Population	100	0.1	15.4	1.96	1.93
Dependent variable					
Death rate	843	0	1	0.027	0.14

Pakistan health indicators are very poor as compared to the other countries in the region such as Pakistan sustained high MMR (Mother Mortality Rate) of 276 per 100,000 live births and the under-five child mortality rate of around 89 deaths per 1,000 live births. Neonatal mortality rate is 49 per 1000 live births and Pakistan accounts for 7% of global neonatal deaths. Improvement in the efficiency may enhance the mother and child health status which further contribute to evolution of human capital. This part of first objective specially focuses on the indicators of mother and child health instead of health inputs and outputs at general level. Mortality is the most commonly used measure of quality (Hussey, Wertheimer et al. 2013). They systematically reviewed the empirical studies of association between cost containment and quality for US between 1990 and 2012. One of the finding of this study was 67 percent of the studies focused on mortality as a quality measure. Moreover, there are some other empirical studies which have used mortality as quality indicator (Hvenegaard, Arendt et al. 2011, Gholami, Higón et al. 2015). As the current study has used mortality as a quality measure without any risk adjustment due to data limitation but this can be considered critically. The differences between the hospitals, districts and provinces is controlled by using regional fixed effects. However, the concentration of the analysis on obstetric services allows a more accurate analysis, while reducing the problem associated with the neglecting risk adjustments.

The variables gynecologist, anesthetist, pediatrician, and WMO residence, ratio-equipment, ratio-medicines, ratio-specialists ratio-WMO, ratio-ambulance, HDI, literacy-rate and population have been selected as control variables at hospital level as well as at district level for the analysis of association between efficiency and quality measure in case of public hospitals from the same data set.

Support services including laboratory, ambulance and radiology services are selected as determinants, as these services will enable the hospitals to perform their services in more efficient manner. HDI values are used to capture population need and social need of the patient in the targeted district. The district level data on very important variables is not available officially. Therefore, data on some variable i.e. HDI (Human Development Index) and MPI (Multidimensional Poverty Index) etc. are developed by researchers[42] and organizations. The data on MPI is utilized from the study of Haroon Jamal (Jamal 2016). This study used the PSLM (Pakistan Social and Living Standard Measurement, 2012-2013) survey data covered 77500 households. These HDI scores ranges from 0 to 1 means the human development increases as we move from 0 to 1. The average score of HDI is almost 48 percent. The study of Haroon Jamal has given equal weights in the measurement of HDI scores to all the indicators i.e. Education, health, and standard of living, whereas, population is used as demographic information.

2.5.2 Empirical Methodology

This section is outlined to explore the relationship between efficiency and quality of private hospitals. To achieve the desired objective, two stages model is sketched; stage one measures the efficiency scores and stage two estimates the relationship between efficiency and quality of care provided by hospitals. To measure the technical efficiency scores, the parametric technique has been selected due to its advantages[43] over non parametric techniques.

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[42] Haroon Jamal from SPDC (Social Policy Development Centre) and Arif Naveed from SDPI (Sustainable Development Policy Institute).

[43] It allows the possibility of random error as SFA is stochastic and it is a parametric technique means it requires the functional form (linear, log-linear, Cobb-Douglas, Translog, e.g...).

2.5.2.1 Efficiency Measurement

Efficiency is measured by examining the relationship between output (product of the healthcare system) and inputs (the resources used to produce that output). The Stochastic Production Frontier of Cobb Douglas form is given below;

$$lny_i = \alpha + ln(x_i')\beta_i + v_i - \mu_i$$

Where y_i represent the output of ith hospital, x_i' is the vector of inputs of ith hospital and $\beta_i$represent the vector of parameters. $v_i,\ and\ \mu_i$ are two parts of error term with the following assumptions,

1. $v_i \sim iidN(0, \sigma_v^2)$
2. μ_i with exponential distribution
3. μ_i and v_i are independently distributed with each other and also with the regressor.

The symmetric error term v_i is the usual error term to allow for random factors like measurement errors, weather, strikes etc. The non-negative error term μ_i is the technical/allocative inefficiency component. Subscript i stand for ith hospital.

2.5.2.2 Relationship between Efficiency and Quality

We are interested to explore how the efficiency score of a hospital affects its quality. To achieve this objective, firstly we have examined the relationship between efficiency and quality using simple correlation coefficient.

The relationship between efficiency and quality might be affected by different confounding variables, for example, physician/specialists' residence availability, ratio of the available and required medicines, equipment etc. Furthermore, population and regional differences might have an effect on morality measures, for example, the poorer regions might have higher mortality, regardless of the quality of the care received.

Mortality is commonly used measure of quality in the literature of health economics (Hussey, Wertheimer et al. 2013). They systematically reviewed the empirical studies of association between cost containment and quality for US between 1990 and 2012. One of the finding of this study was 67 percent of the studies focused on mortality as a quality measure. Moreover, there are some other empirical studies which have used mortality as quality indicator (Hvenegaard, Arendt et al. 2011, Gholami, Higón et al. 2015). Pakistan's sustained high MMR of 276 per 100,00 live births and mortality rate for under five of 89 per 1000 live births, indicate that Pakistan's health indicators are very poor compared to other countries. With relatively high maternal and neonatal mortality in Pakistan, mortality is likely to be a suitable measure of quality. Two techniques e.g. Least Square Dummy Variable and Two Stage Residual Inclusion have been used for exploring the relationship between objective quality and technical efficiency of a public hospital.

2.5.2.2.1 Least Square Dummy Variable (LSDV)

The quality of the services provided by the hospital is measured using the mortality rate. The objective of the study is to explain the relationship between dependent variable quality and independent variable technical efficiency score of a hospital. This study aims to measure the size and direction of the effect. To find unbiased estimates, we have controlled confounding variables, both unobservable and observable. Therefore, we have used multiple linear regression models to capture observable control variables. While to control unobservable confounding variables, fixed effect linear regression model is used. Following the previous literature (Wagstaff 1989, Olsen and Street 2008, Hvenegaard, Arendt et al. 2011), this study constructs the efficiency and quality measure by postulating fixed-effect model to evaluate the relationship of efficiency and delivered quality at each hospital, recognizing the districts and provinces in which the hospitals located. Our model is defined as:

$$q_{ij} = \theta + \theta_j + \beta_1 E_{ij} + \beta_2 X_{ij} + \beta_3 W_j + u_{ij}$$

Where q_{ij} is the quality of a hospital i in district j , E_{ij} is the efficiency of a hospital i in district j and X_{ij} is the vector of observable confounding variables at hospital level and W_j at district level as explained in the data and variable section. Whereas, θ_j is district specific constant/ fixed effects. Where u_{ij} is the error term which captures the unobservable characteristics of a hospital and district. θ_j is risk adjusted quality and it is refer as district effect.

When the number of units (districts) is small then the district effects can be estimated using Least Square Dummy Variable (LSDV) estimator. LSDV estimator is achieved as OLS estimates with district dummies included as independent variables. LSDV estimates of θ_j given θ and β as:

$$\hat{\theta}_j = \bar{q}_j - \hat{\theta} - \hat{\beta}\hat{X}_j$$

This is unbiased estimate of district effects given that the confounding variables are exogenous.

$$E\left(u_{ij} \setminus X_1, \dots \dots \dots .., X_n\right) = 0$$

The district effect can be defined more generally given the assumption of heterogeneity as the difference between expected and observed district quality. Whereas, the district expected quality is obtained using control variables but not district information.

$$\theta_j = \bar{q}_j - E(\bar{q}_j / \theta, \beta, \bar{X}_j)$$

θ_j will have positive value if the observed value is greater than the expected value of quality and vice versa. Fixed effect specifications have two main advantages; first it explicitly provides the estimates of district effects and the other is it is unbiased even if the district effects θ_j and control variables are correlated.

2.5.2.2.2 Two-Stage Residual Inclusion (2SRI)

Following Terza, Basu et al. (2008), 2SRI method is used to control the potential endogeniety due to simultaneity between technical efficiency and quality. In 2SRI approach, we first estimate the equation for endogenous variable which is efficiency in this case as follows.

$$E_i = \beta_o + \beta_1 X + \beta_2 Z + e$$

Where X is the vector of control variables, Z is the vector of instrumental variables, e is the stochastic error term and $E_i$is the technical efficiency score of hospital. The instruments used for efficiency of a hospital are ratio equipment, ratio women medical officer and ratio ambulance as these variables directly affect technical efficiency of a hospital.

For second stage of 2SRI, residual are obtained after first stage regression and which is used as an additional explanatory variable in the second stage regression. Then the estimable equation becomes,

$$q_{ij} = \alpha_o + \alpha_1 X_{ij} + \alpha_2 W_j + \alpha_3 e^{2SRI} + \mu_{ij}$$

Where q_{ij} is the quality of a hospital i in district$j$, e^{2SRI} is the predicted residuals from the first equation, μ_{ij} is the error term which captures the unobservable characteristics of a hospital and a district and X_{ij} is the all the other hospital level control variables and W_j is district level control variables. Testing whether $\alpha_2$is significantly different from zero or not. If we reject the null hypothesis that α_2 is not significantly different from zero, it means that underlying variable is endogenous (Bollen, Guilkey et al. 1995).

The same second stage equation has been estimated considering district and province level fixed effects separately in two models,

$$q_{ij} = \alpha_o + \alpha_1 X_{ij} + \alpha_j + \alpha_2 e^{2SRI} + \mu_{ij}$$

This equation has been estimated twice considering α_j once district fixed effects and secondly it is estimated with province fixed effects. The whole model of 2SRI is estimated using the program of 2SRI in Stata and Bootstrapping technique is used for correcting the standard errors with 1000 replications (Terza 2017).

2.6 RESULTS AND DISCUSSION

This section of the chapter is broadly divided into two main parts. The efficiency scores of the public hospitals are discussed in the first part and second part contain the discussion on the relationship between objective quality indicator[44]and technical efficiency of the hospitals at DHQ, THQ and RHC level.

2.6.1 Efficiency Measurement

This study has applied Stochastic Frontier Analysis (SFA) production function to estimate efficiency scores at hospital level. SFA is a parametric technique of efficiency analysis and it is based on econometric regression model. It is parametric and require functional form. It allows for the random error along with the inefficiency term. SFA estimates of technical efficiency lie between 0 and 1. The efficiency scores increases when we move from 0 to 1. If the efficiency score is 1 that means specific hospital is fully efficient while, if the estimated efficiency score is less than 1, then it will define that specific hospital lies below the frontier. In case of output-oriented model, maximum output is achieved by utilizing given set of inputs. So, for minimizing the inefficiencies, highest level of output should be attained with the fixed set of inputs.

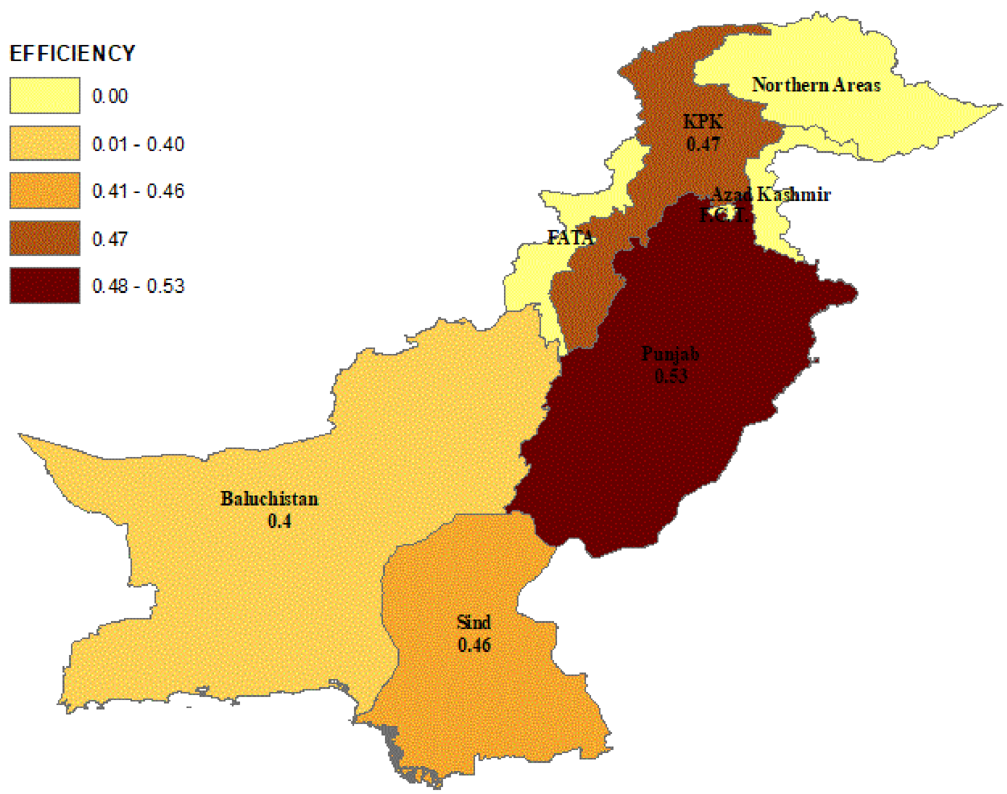
The results reveal that none of the public hospital lies on the frontier, implying that not a single hospital is fully efficient. The most efficient hospital is a Rural Health Centre (RHCs) from

[44] Number of maternal mortality and neonatal mortality is taken as quality indicators.

district Battagram located in KPK province. Its efficiency score is 0.84 which implies this hospital is 84 percent efficient and still there is 14 percent chance of improvement. Whereas, the minimum efficiency score is 0.01 of a THQH from district Rajanpur located in Punjab.

The overall average efficiency score of 843 public hospitals is 0.48 which includes four kinds of hospitals (DHQH, THQH, RHCs and CH). Hence, the hospitals are only 48 percent efficient and 52 percent more output can be achieved using the same level of inputs. The average efficiency scores of across four provinces of Pakistan are presented in the figure 2.6.

Figure 2.6 Average Technical Efficiency Scores at Province Level



Source: Author's own calculations

The number of hospitals in Punjab is 362, which is greater than the other three provinces and its average efficiency score is also higher than the others but still, it is very low. Its efficiency score is 0.53 which means 47 percent below the frontier. Whereas, KPK and Sindh contain almost same number of hospitals and their efficiency scores are approximately equal, which is 0.47 and 0.46 respectively. The inefficiency levels in these two provinces are more than 50 percent which is alarming. Since Baluchistan has least efficiency score (0.40), it can increase the output by 60 percent using the same resource. For heterogeneous analysis, the efficiency scores are discussed by hospital type in table 2.4.

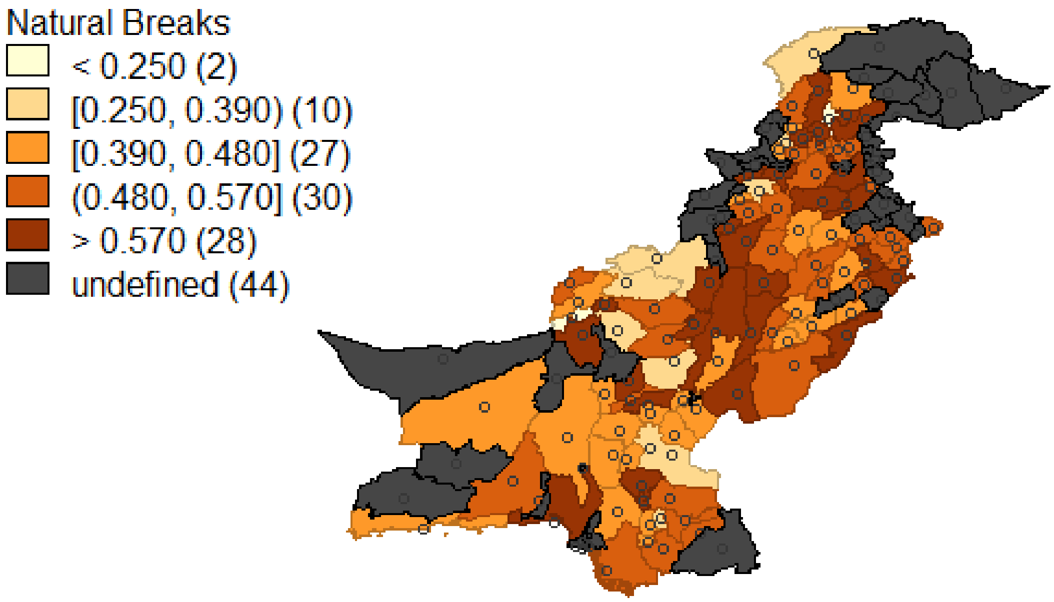
Table 2.4 Average Efficiency Scores by Hospital Type

Hospital Type	Efficiency score	No of hospitals
DHQH	0.53	85
THQH	0.44	154
RHCs	0.49	539
CH	0.60	65

The number of RHCs are higher in comparison to other hospital types in the dataset of 843 hospitals, but their average efficiency scores are below 50 percent indicates that there is 51 percent wastage of resources. While, the Civil Hospitals (CH) are less in number, but their average efficiency scores are better as compared to other types of hospitals. District Head Quarters (DHQH) are large scale hospitals and mostly include one or two such kinds within a district. As, their efficiency scores are 53 percent, it infers that there is 47 percent chance of improvement.

The technical efficiency scores at district level are provided in the appendix section and their summary is given in the following Figure.

Figure 2.7 Average Efficiency scores at District Level



Source: Author's own calculations

There were 141 districts in four provinces of Pakistan at the time of survey, but the data is available for only 97 districts and the rest are undefined. The results reveal that not a single district is working on the production frontier which implies that none of the district is fully efficient. The average efficiency score is 0.46 which is very low. The most efficient district is Burkhan from Baluchistan province whose efficiency score is 0.76; which is around 76 percent efficient and has 24 percent scope of improvement. While, the second most efficient district is Kohat from KPK with efficiency score 0.67; it indicates that a 37 percent more output can be achieved with the same level of inputs. Whereas, the third most efficient district is Jhelum from KPK which efficiency score is 0.66 and still there is 34 percent chances of improving the production process. The performance of four districts is below 20 percent which is very low, and these districts are Harnai, Washuk and Quetta from Baluchistan Province and Shangla from KPK. Therefore, there is an 80% scope of improvement towards health provision. Harnai is the most inefficient district with 10 percent of efficiency score which indicates that 90 percent output can be enhanced with the same level of inputs.

2.6.2 Efficiency Quality Nexus

The correlation between the death rate[45] and technical efficiency is negative, and its value is 0.16 which indicates with an increase in efficiency level, there is a potential decrease in maternal and neonatal death rates of public hospitals; as, this study has considered the death rate as a quality indicator. Hence, fall in death rate means upsurge in quality of a hospital. So, the negative relation between death rates and efficiency reveals that when efficiency of a hospital increases, the quality also increases; means positive relationship between quality and efficiency.

In this chapter we are analyzing the impact of technical efficiency on the quality indicator which is death rate (continues variable). So, if the dependent variable is continuous, then we apply OLS regression for the analysis. To achieve the above stated objectives, five different models are estimated. The relationship between efficiency and quality is estimated without any control variables in model 1. Hospital level and district level variables are controlled in model 2 and 3 respectively for heterogeneity analysis. District level fixed effects and province level fixed effects are captured in model 4 and 5 respectively and detail results are available in appendix. The results are presented in the table 2.5. The results reveal that there is negative association between death rate and technical efficiency. The coefficient of efficiency is negative and highly significant (p value is less than 0.01). Therefore, the quality and efficiency have positive relationship; means if the hospitals increase their efficiency level, then quality will also increase.

[45] Death rate is the more appropriate measure of quality. It is number of deaths per delivery which is simply measured as the ratio of number of deaths to deliveries.

Table 2.5 Relationship between efficiency and Death rate

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Efficiency	-0.107*** (0.035)	-0.11*** (0.037)	-0.109*** (0.0368)	-0.106*** (0.037)	-0.114*** (0.038)
Gynecologist residence	----	-0.008 (0.024)	-0.0081 (0.023)	-0.011 (0.024)	-0.0122 (0.026)
Anesthetist residence	----	0.0051 (0.027)	0.0056 (0.026)	0.0066 (0.027)	0.0015 (0.027)
WMO residence	----	0.0068 (0.0184)	0.0072 (0.0104)	0.0053 (0.0187)	0.0198 (0.0183)
Pediatrician residence	----	0.0052 (0.0182)	0.0058 (0.019)	0.0108 (0.0108)	0.0282* (0.015)
Ratio equipment	----	-0.0374 (0.0297)	-0.0395 (0.033)	-0.0298 (0.0033)	-0.036 (0.046)
Ratio Medicines	----	0.0336 (0.025)	0.0305 (0.0257)	0.034 (0.026)	0.0451 (0.030)
Ratio specialists	----	0.0093 (0.0142)	0.0104 (0.0143)	-0.0049 (0.010)	-0.0014 (0.013)
Ratio WMO	----	-0.0036 (0.012)	-0.004 (0.010)	0.0132 (0.0135)	0.0155 (0.014)
Ratio Ambulance	----	0.0093 (0.015)	0.0098 (0.0138)	0.0135 (0.0154)	0.0096 (0.017)
HDI	----	----	-0.018 (0.061)	0.0054 (0.0051)	0.437 (0.343)
Literacy rate	----	----	-0.0004 (0.0005)	-0.0005 (0.0005)	-0.175 (0.132)
Population	----	----	0.0037 (0.0046)	0.0168 (0.092)	0.841 (0.612)
Constant	0.079*** (0.021)	0.068*** (0.023)	0.094*** (0.0304)	0.0492 (0.058)	3.786 (2.93)
N	843	843	843	843	843
District fixed effects	No	No	No	No	Yes
Province fixed effects	No	No	No	Yes	No

Note: Standard errors are given in parenthesis. ***, ** and * show significance at 1%, 5% and 10% levels of significance respectively

Previous empirical researchers have also found positive association between quality and operational efficiency of the hospitals (Clement, Valdmanis et al. 2008, Nayar and Ozcan 2008). According to the results of model 2 and 3, all the variables at hospital level as well as district level are insignificant. Hence, the coefficient of the efficiency remains unaltered after controlling these variables. Furthermore, in model four and five, we have used district and province fixed effects to capture the regional differences which might have an effect on morality measures. For example, the deprived districts might have higher mortality, regardless of the quality of the care received. However, the findings of the models show that still efficiency has a negative effect on maternal and neonatal mortality after controlling the regional fixed effects.

When the production process of a hospital is efficient, it means the hospital operates at maximum output with given resources. Hence, the technical efficiency is the measure of production process. On the other hand, deprived quality is associated with problems of efficiency as wastage of resources is also a dimension of quality. Consequently, healthcare quality is also a part of operational efficiency (Nayar and Ozcan 2008). So, this association has significant implications for management and health policy (Gholami, Higón et al. 2015). Prior empirical research investigating the relationship in maternity care, have shown mixed findings. (Williams, Cunningham et al. 1980) suggested positive association between number of births and quality which is measured as prenatal mortality. Using hospital discharge data, (Heaphy and Bernard 2000) showed that hospitals with higher volume of deliveries were less likely to have higher death rates and complications. Likewise, Garcia et al., showed that complications in deliveries decrease with increase in volume. Contrarily, a study reported that high risk of maternal injury is associated with high obstetric volume (Grobman, Feinglass et al. 2006).

There can be the problem of simultaneity between quality and efficiency, as efficiency is an endogenous variable itself. There can be a causal relationship between these two variables. Furthermore, hospitals that have economic pressure are forced to increase their efficiency, maybe at the cost of lower quality. So, undetermined causal direction is endogeniety. To tackle the problem of endogeniety, 2SRI technique is used and results are displayed in the following table.

The relationship between efficiency and quality is estimated without any control variables in model 1. Hospital level and district level variables are controlled in model 2 and 3 respectively for heterogeneity analysis. District level fixed effects and province level fixed effects are captured in model 4 and 5 respectively.

Table 2.6 Two-Stage Residual Inclusion (2SRI)

	Model 1	Model 2	Model 3	Model 4 (D)	Model 5 (Pr)
Efficiency	-0.107**	-0.111**	-0.111**	-0.113**	-0.106**
	(0.0337)	(0.0351)	(0.035)	(0.0399)	(0.0347)
Xuhat	-1.037	-0.971	-1.022	-0.638	-1.525
	(1.253)	(1.307)	(1.141)	(1.261)	(1.055)
Ratio Medicines	----	0.0179	0.015	0.0375	0.0235
		(0.0229)	(0.0242)	(0.0309)	(0.0244)
Ratio specialists	----	0.00629	0.00738	0.0137	0.0127
		(0.013)	(0.0138)	(0.017)	(0.0134)
Gynecologist residence	----	-0.0086	-0.0086	-0.0125	-0.0116
		(0.0231)	(0.0232)	(0.0268)	(0.024)
Anesthetist residence	----	0.00466	0.00551	0.00198	0.00813
		(0.0268)	(0.0271)	(0.0248)	(0.0281)
Pediatrician residence	----	0.00526	0.00579	0.0195	0.00497
		(0.0184)	(0.0184)	(0.0197)	(0.0187)
WMO residence	----	0.00367	0.00428	0.0272	0.00909
		(0.0101)	(0.0103)	(0.0173)	(0.0108)
Literacy rate	----	----	-0.0004	-0.169	-0.000477
			(0.0005)	(0.125)	(0.00053)
Population	----	----	0.00348	0.421	0.00572
			(0.0046)	(0.309)	(0.0051)
HDI	----	----	-0.0318	8.086	0.0262
			(0.0652)	(0.106)	(0.0906)
Constant	0.0908***	0.0773**	0.109**	3.663	0.0609
	(0.0273)	(0.0276)	(0.0339)	(2.588)	(0.0536)
N	843	843	843	843	843
District fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	No	Yes

Bootstrap Standard errors in parentheses

* p<0.05, ** p<0.01, *** p<0.001

According to the results, the coefficient of efficiency is negative and highly significant in all the models. Results of 2SRI are in line with LSDV and the residual (Xuhat) obtained from first stage regression is insignificant indicating the exogeneity of technical efficiency. If the residual has a significant effect on death rate, we could treat the efficiency as endogenous regressor.

We have also applied Hausman test to check the endogeniety of efficiency and the value obtained from χ^2 test is 0.26 which is insignificant (as p value is high 0.613) which also indicate the exogeneity of efficiency.

Data used in this study mainly contains secondary level hospitals DHQH, THQH and CH (District and Tehsil Headquarters and Civil Hospitals) and RHCs (Rural Health Centers). All these hospitals are included in our main analysis. The size in terms of output and input variables of all type of hospitals are not same and thus, sensitivity analysis is vital for further exploration.

The findings of the relationship between efficiency and death rate for DHQH is provided in the table 2.7. The empirical findings for DHQ hospitals also reveal negative association between death rate and technical efficiency. The coefficient of death rate is negative and highly significant. Therefore, the quality and efficiency have positive relationship, which means increase in level of efficiency of a DHQ hospital leads to an increase in the quality of that hospital. THQ hospitals are also secondary healthcare hospitals located at tehsil headquarters level. It serves about 0.5 to 1.0 million population and contains almost 40 to 60 beds. It provides diagnostic, preventive, curative, inpatients, referral and specialist services as well as basic and emergency obstetric and newborn care. The findings of the relationship between efficiency and death rate for THQH is provided in the table 2.8.

Table 2.7 Relationship between Efficiency and Death rate for DHQH

Variables	Model1	Model2	Model 3
Efficiency	-0.264***	-0.248***	-0.236***
	(0.0705)	(0.077)	(0.076)
Gynecologist residence	----	-0.0283	-0.0262
		(0.0346)	(0.0346)
Anesthetist residence	----	0.0145	-0.00857
		(0.0407)	(0.0412)
Pediatrician residence	----	-0.0211	-0.0222
		(0.0359)	(0.0359)
WMO residence	----	0.0194	0.00720
		(0.0285)	(0.0285)
Ratio equipment	----	0.0268	0.0756
		(0.109)	(0.109)
Ratio medicines	----	0.0666	0.115
		(0.076)	(0.079)
Ratio specialists	----	-0.0154	0.0029
		(0.052)	(0.062)
Ratio WMO	----	-0.0087	0.0048
		(0.023)	(0.024)
Ratio Ambulance	----	0.0414	0.0828
		(0.073)	(0.074)
HDI	----	----	0.458
			(0.277)
Literacy rate	----	----	-0.0023*
			(0.0013)
Population	----	----	-0.026*
			(0.014)
Constant	0.166***	0.0710	-0.122
	(0.0394)	(0.130)	(0.170)
Observations	85	85	85
R-squared	0.144	0.184	0.247

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results of empirical regression for THQ hospitals showed negative relationship between efficiency and death rate. The coefficient of death rate is negative and highly significant. Therefore, the quality and efficiency of THQH have positive relationship, which means if the hospitals increase the level of efficiency, the quality will also increase. RHCs are primary healthcare hospitals and one hospital serves up to 10,000 people. An RHC contains almost 10 to 20 beds. It provides diagnostic, curative, preventive, promotive, referral and inpatient services except specialized services which are offered by the secondary healthcare hospitals. For the provision of basic and emergency obstetric and new born care, human resources are available except the specialists' (e.g. gynecologists, anesthetists and pediatricians). Therefore, the RHCs do not offer surgical delivery (cesarean section) of a newborn. The results of the relationship between efficiency and death rate for RHCs are presented in the table 2.9.

Table 2.8 Relationship between Efficiency and Death rate for THQH

Variables	Model1	Model 2	Model 3
Efficiency	-0.177***	-0.188***	-0.171***
	(0.048)	(0.050)	(0.048)
Gynecologist residence		0.023	0.029
	----	(0.026)	(0.025)
Anesthetist residence		0.001	0.033
		(0.034)	(0.033)
Pediatrician residence	----	0.038	0.028
		(0.029)	(0.028)
WMO residence	----	-0.018	-0.025
		(0.020)	(0.019)
Ratio equipment	----	-0.083	-0.091
		(0.074)	(0.073)
Ratio medicines	----	0.054	0.084
		(0.060)	(0.061)
Ratio specialists	----	0.045*	0.050**
		(0.023)	(0.023)
Ratio WMO	----	-0.019	-0.005
		(0.017)	(0.017)
Ratio Ambulance	----	0.041	0.032
		(0.065)	(0.063)
HDI	----		0.236
			(0.203)
Literacy rate	----	----	-0.004***
			(0.001)
Population	----	----	-0.007
			(0.008)
Constant	0.102***	0.062	0.136
	(0.023)	(0.070)	(0.093)
Observations	154	154	154
R-squared	0.082	0.149	0.230

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results for RHCs reveal that the technical efficiency of a hospital is negatively associated with death rate of that hospital. The coefficient of efficiency in the all three models are negative and highly significant. In RHCs, the output variable for the efficiency measurement is only normal deliveries because such hospitals do not provide the facility of surgical mode newborn delivery. So, in the situation where only Women medical officer (WMO), nurses and other technical staff are available for normal deliveries, the findings for the relationship between efficiency and quality are same.

Table 2.9 Relationship between Efficiency and Death rate for RHCs

Variables	Model1	Model2	Model3
Efficiency	-0.079**	-0.079**	-0.081**
	(0.032)	(0.035)	(0.035)
Gynecologist residence	----	----	----
Anesthetist residence	----	----	----
Pediatrician residence	----	----	----
WMO residence	----	0.005	0.008
		(0.015)	(0.015)
Ratio equipment	----	-0.062	-0.063
		(0.047)	(0.048)
Ratio medicines	----	0.025	0.016
		(0.039)	(0.040)
Ratio specialists	----	----	----
Ratio WMO	----	-0.002	-0.003
		(0.012)	(0.012)
Ratio Ambulance	----	0.018	0.020
		(0.020)	(0.020)
HDI	----	----	-0.125
			(0.141)
Literacy rate	----	----	0.001
			(0.001)
Population	----	----	0.005
			(0.004)
Constant	0.068***	0.069**	0.091*
	(0.017)	(0.028)	(0.049)
Observations	539	539	539
R-squared	0.011	0.015	0.020

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Civil Hospitals (CH) are also secondary healthcare hospitals and provide the same facilities as DHQH and THQH. The outcomes of the relationship between efficiency and death rate for CH are presented in the table 2.10.

Table 2.10 Relationship between Efficiency and Death Rate for CH

Variables	Model1	Model2	Model3
Efficiency	-0.0583*	-0.014*	-0.015*
	(0.0445)	(0.056)	(0.058)
Gynecologist residence	----	-0.016	-0.030
		(0.047)	(0.050)
Anesthetist residence	----	0.016	0.039
		(0.102)	(0.107)
Pediatrician residence	----	0.001	-0.007
		(0.036)	(0.039)
WMO residence	----	0.022	0.023
		(0.023)	(0.025)
Ratio equipment	----	0.036	0.044
		(0.099)	(0.106)
Ratio medicines	----	-0.126*	-0.132*
		(0.070)	(0.076)
Ratio specialists	----	0.083	0.112
		(0.152)	(0.156)
Ratio WMO	----	-0.043	-0.038
		(0.065)	(0.070)
Ratio Ambulance	----	-0.034	-0.034
		(0.038)	(0.039)
HDI	----	----	-0.250
			(0.410)
Literacy rate	----	----	0.002
			(0.002)
Population	----	----	-0.015
			(0.022)
Constant	0.0406	0.088**	0.127
	(0.0246)	(0.039)	(0.138)
Observations	62	62	62
R-squared	0.028	0.151	0.174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results for CH show that the efficiency and death rate are negatively related. The coefficient of the efficiency are negative and significant at 10 percent level of confidence.

2.7 CONCLUDING REMARKS

This study has explored the performance of public sector healthcare units in the context of mother and child health in Pakistan. Previous studies have very limited geographic coverage and hence face the problem of external validity. The current study covers the entire country and hence its results can be generalizable. Secondly, we have examined the relationship between efficiency and quality in a developing country. Hence, this study also added to the existing public health literature that explores the correlates of the quality of service provision.

To achieve the objectives, the data has been taken from Health Facility Assessment (HFA) survey which was conducted by the Ministry of Health with technical support of TRF in 2010/11. NMCHP was established by the Ministry of Health in Pakistan. The main goal of this programme was to improve the maternal health outcomes and assist with achievement of the Millennium Development Goals. According to the results of this study, the efficiency scores of all types of public hospitals are not satisfactory. None of the hospitals is working on production frontier. On the other hand, there are many hospitals with zero efficiency scores which is an alarming situation. Hence, output can be increased with the same level of resources.

The results of the second stage of analysis reveal that a negative association exists between maternal and neonatal mortality and technical efficiency. The coefficient of mortality is negative and highly significant. Therefore, the quality and efficiency have positive relationship means if the hospitals increase the level of efficiency, the quality will also be enhanced.

Quality in hospital sector is a topic of growing awareness for policymakers. Any hospital's main aim should be improving health outcomes. According to the empirical literature, the volume of the hospital is the main determinant of quality (Begg, Cramer et al. 1998, Hentschker and Mennicken 2012). It is a common empirical hypothesis that higher volume is an indicator of obtaining better health outcomes. Therefore, high hospital volume is directly proportional to increased level expertise, improved patient management and organizational skills, which all in turn leads to decrease in adverse health outcomes. High volume hospitals work frequently, which allows a higher level of learning (Gandjour and Lauterbach 2003). Moreover, larger hospitals positively impact health outcome due to learning environment, broader skill-mix in staffing and economies of scale. In the literature of volume, this concept is referred as "practice-makes-perfect" (Gaynor, Seider et al. 2004). Mortality rate is most frequently used measure for quality of a hospital (Barker, Rosenthal et al. 2011). Mostly the empirical investigations focus on particular conditions e.g. interventions for patients with cancer surgery (Begg, Cramer et al. 1998), lungs (Hannan 1999), hip fracture (Sund 2010, Malik, Panni et al. 2017), AIDs (Hogg, Raboud et al. 1998) and maternal outcomes (LeFevre 1992, Chang, Stamilio et al. 2008).

In the interpretations of our findings, technical efficiency is negatively associated with maternal and neonatal death rates means positively related to quality measure. Technical efficiency is achieving maximum output with given resources and the outcome variable in our study is the number of deliveries. Increase in efficiency level of a hospital means rise in its volume. Therefore, higher volume is associated with low risk of maternal and neonatal deaths. So, findings of our study support the hypothesis, "practice makes perfect". It can be explained by many justifications e.g. learning by doing, economies of scale lead to increased specialization. As, higher number of deliveries leads to specialization of the staff, nurses, doctors, specialists and hospital as well. Our study based on a large population, so the results can be more generalizable.

In conclusion, the current study suggests that risk of maternal and neonatal mortality is relatively higher in less efficient hospitals as compared to the more efficient ones. In developing countries like Pakistan, the government and policymakers should be more focused on improving the efficiency of the public hospitals. Then, the technical efficiency will further lead to better quality outcomes. Our country is already facing the problem of scarce resources, the efficiency scores of all the hospitals are very low according to the findings of our study. These scarce resources can be utilized to enhance the efficiency level. Thus, the increased efficiency of a hospital will further contribute to improving quality of care.

2.8 LIMITATIONS OF THE STUDY

Productive efficiency or economic efficiency is determined by combining the concept of allocative and technical efficiency. The main focus of this study is measurement of technical efficiency. One of the major limitations of the present study is that allocative part of economic efficiency is missing due to data constraint. The estimation of allocative efficiency requires data on prices of inputs and outputs, expenditures and revenues, of a hospital. However, the required data was not available in survey of public hospitals.

Moreover, for public hospitals, the main focus of the study is maternal child health due to data limitation. Hence, the efficiency measured for these healthcare units are only related to mother and child healthcare and not for the other services that hospitals provided.

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Chapter 3

TRADEOFF BETWEEN EFFICIENCY AND PERCEIVED QUALITY: EVIDENCE FROM PATIENT LEVEL DATA

3.1 INTRODUCTION

Quality is a crucial component of goods and services, such that organizations and firms consider it as an important aspect of production process. Definition of quality depends on the perspective/context in which it is considered. In general, it is hard to define, due to its subjective nature. In literature, various definitions of quality exist (Mosadeghrad, 2014). Defining healthcare quality and its measurement, is even more challenging as compared to other sectors. Its distinct characteristics of heterogeneity, intangibility, and simultaneity complicates its measurement band definition. Firstly, healthcare quality is an intangible product as it cannot be physically touched, viewed and measured as compared to other manufactured goods. Secondly, the needs of the patients vary and therefore any good care must take individual circumstances into account, making it hard to compare across patients and diseases. Heterogeneity can occur because service providers (e g specialists, doctors, nurses etc.) can vary according to the need of the patients and patients are heterogeneous in their physical and demographic status as well as their response to the treatment. Lastly, these services are produced and used simultaneously, as it cannot be stored. Therefore, patients cannot judge the quality of healthcare services. The concept of healthcare quality is complex, subjective and multidimensional (Mosadeghrad, 2014; Parasuraman, Zeithaml, & Berry, 1985).

Six major areas (safe, effective, patient-centered, timely, efficient and equitable) are highlighted for a better healthcare system, in the report of Institute of Medicines and World Health Organization(Medicine, 2004; Organization, 2006). According to these reports, the healthcare system should be safe firstly, it means provided care from the hospital avoids injuries to patients. Secondly, these services should be effective, the services must be grounded on scientific knowledge. Thirdly, the healthcare system should be responsive to patients' preferences. Fourth, the system must try to reduce waiting time and hurtful delays. The fifth area that must be focused for a better healthcare system is efficiency[46] means to avoid wastage of resources. At the last, the quality of provided care should not be discriminated on the basis of personal characteristics such as ethnicity, gender and geographical location etc. Healthcare quality assessment is usually concerned about the technical aspects, and the service delivery process. An effective healthcare system can operate properly if it considers patients' perceptions and modifies itself according to the feedback (Aharony & Strasser, 1993). World Health Organization (Organization, 2000) has defined healthcare quality in their health report through cost effectiveness, efficiency and social acceptability. Acceptability includes patients' satisfaction, physicians attitude and perceived quality of care (Dewa, Loong, Bonato, & Trojanowski, 2017). Patient's perceptions are clearly included in the social acceptability concept. Thus, patients' perceptions are very important in the measurement of overall quality of a healthcare provider (Shaikh, 2005).

Patients' perceptions towards the healthcare services, is a subjective indicator and it is very similar with satisfaction. It is evident in the literature (Sitzia & Wood, 1997; Williams, 1994) that satisfaction and perceptions are used interchangeably. Often, satisfaction is considered as an indicator of patients' perceptions and defined as patient's reaction to healthcare services. Patients then evaluate these services including physical and human resources subjectively. Although all the

[46] There are mainly two types of efficiency such as technical efficiency and allocative efficiency. Whereas, the focus of this thesis is on technical efficiency. Technical efficiency is achieving maximum output given a set of inputs (output oriented) or to consume minimum inputs given a level of output (input oriented).

patients cannot judge the technical aspects but they provide accurate information regarding the services they received (Schoenfelder, Klewer, & Kugler, 2011).

Previous literature on determinants of patients' satisfaction identified numerous factors which can directly affect the level of satisfaction (patients' experiences). These include, technical care (ability, experience and competency of health professionals) (Senarath et al., 2013), interpersonal care (amount of care patient receive) which further incorporates care provided by physicians and nurses (Bjertnaes, Sjetne, & Iversen, 2012; Swan, Richardson, & Hutton, 2003), physical environment which measures factors like comfort and cleanliness etc. (Andaleeb, 2001), accessibility (Naidu, 2009), availability (Badri, Attia, & Ustadi, 2009) affordability (Victoor, Delnoij, Friele, & Rademakers, 2012), organizational characteristics that looks at continuity and efficacy (Ware, 1978), patient related characteristics such as age, gender, education, socio-economic and marital status (Carlin, Christianson, Keenan, & Finch, 2012; J. G. Chen, Zou, & Shuster, 2017; Hall & Dornan, 1990), geographic characteristics include residence area (Atkinson & Haran, 2005) and geographical region (DeVoe, Fryer Jr, Straub, McCann, & Fairbrother, 2007), length of stay (Borghans, Kleefstra, Kool, & Westert, 2012), health status (Hekkert, Cihangir, Kleefstra, van den Berg, & Kool, 2009), and expectations (Bjertnaes et al., 2012).

Technical efficiency of a hospital, which is the maximization of outcome may have indirect effect on the level of satisfaction of the patients. When a hospital aims to increase its efficiency, it is more focused on enhancing the volume of patients with the given set of resources. Therefore, in effort to increase hospital performance, many other factors such as waiting and consultation time, physician burnout, attitudes of healthcare providers, interpersonal skills (communication between healthcare providers and patients) and physician-patients ratio, may in turn get affected. According to previous empirical literature, these factors, adversely affect patients' satisfaction

(Anagnostopoulos et al., 2012; J. Y. Chen et al., 2008; Dewa et al., 2017; Samina, Qadri, Tabish, Samiya, & Riyaz, 2008). Hence, technical efficiency might affect the acceptability aspect of healthcare quality indirectly, but to the best of my knowledge, this aspect has not been examined in the published literature. As of now, literature does not include technical efficiency in determinants of patients' satisfaction. Given its importance, efficiency may have a significant impact on level of satisfaction. Identification of the relevant factors, could help improve the quality of services and is, therefore, an important aim of the current study.

The interest in improvement and measurement of healthcare service quality has increased throughout the world due to increase in healthcare expenditures, demand and constraint resources. Improvement in healthcare quality is on the top of agenda of developed nations (Campbell, Roland, & Buetow, 2000). Whereas, quality of healthcare services has not been focused in developing countries and especially consumer perceptions is the most ignorant area in healthcare research (Ayat, Khalid, & Mahmood, 2009; Yıldız & Erdoğmuş, 2004).

Many factors[47] are responsible for deteriorating quality of Pakistan healthcare system and of these, patients' satisfaction may be one of the most ignored element in healthcare quality improvement. The assessment of patients' point of view (perceptions) not only is important to identify the problems in quality assessment, but it will also provide a way forward towards improvement in the existing condition of public healthcare system. Therefore, given the conditions of quality of public healthcare system in Pakistan and the importance of consumer's perceptions for improving healthcare system, there is need to evaluate the quality of healthcare providers from

[47] Absence of healthcare evaluation, ignorance of the importance of patients' point of view in management, accredited standards and low spending on health sector by government. As Pakistan's spending on health sector is 0.5 to 0.8 percent of GDP which is very minimal and less than the bench mark of WHO (6 percent of GDP). Pakistan per capita healthcare spending is US $36.2 whereas, WHO benchmark for low income countries is US $86 (Pakistan Economic Survey, 2016-17).

patients' perspective. Further examine the factors which are responsible for deteriorating perceived quality of healthcare.

This chapter has explored the relationship between technical efficiency of healthcare units (DHQs hospitals), and the patients' perceptions about the quality of services with respect to mother and child health. Furthermore, the main factors that could result in patients' satisfaction or dissatisfaction with subjective quality of services has also be investigated.

Development and welfare is the basic right of every single individual according to the charter of United Nations and constitution of Pakistan and health is the main contributor of people's welfare. Considering the importance of healthcare evaluation and quality improvement, this study links performance measurement with patients' perception about healthcare system. It's important to explore whether striving for higher efficiency actually hurts patients. Technically, the performance of a hospital is measured through obtaining maximum health outcomes. This high performance could be related to the patients' point of view about the healthcare provider. Given the importance of patients' satisfaction towards improvement in healthcare care services and for the betterment of health conditions of individual, this study identifies the factors which could affect the relationship in both directions.

In this chapter, we have explored the relationship between technical efficiency of Pakistan's public hospitals and patients' perception in the context of mother and child health. Furthermore, this study covers all the DHQs hospitals from all the districts of Pakistan, so the results can be generalizable (true representation) for the whole country. Secondly, this chapter explores the impact of a hospital's efficiency on the level of satisfaction of a patient and identifies factors affecting the relationship between efficiency and patient's satisfaction.

The findings of this chapter reveal that negative association exists between technical efficiency and patients' level of satisfaction which indicates with the increase (decrease) in hospital efficiency, the satisfaction level of the patients tends to decrease (increase).

Rest of the chapter is organized as follows: The second section presents detailed literature review. The data, variables and econometric methodology used in this chapter is discussed in the third section. Results are discussed in fourth section and the last section provides the concluding remarks, some policy suggestions and future research gap.

3.2 LITERATURE REVIEW

Over last few decades, the world has drifted its focus from industry to services. Healthcare service sector is considered faster growing as compared to other sectors due to its increased demand and growth in cost during the last few decades (Fitzsimmons, Fitzsimmons, & Bordoloi, 2008). Moreover, quality of the services is well-thought-out very important in both developed and developing countries. Organizations and firms from all over the world contemplate quality as an important part of production process due to increased demand from consumers (Mosadeghrad, 2014). Healthcare quality is subjective, multi-dimensional, broad ranging concept and its measurement requires appropriate choice of consensual variables that show the healthcare system's complexity (Hibbard, Mahoney, Stockard, & Tusler, 2005).

There exist many definitions of healthcare quality in literature. Many researchers define the concept of consumer perceptions and quality of services in healthcare sector (Aharony & Strasser, 1993; Mohammad Mosadeghrad, 2013). For describing the healthcare quality, six factors are very important. These are, efficiency, efficacy, effectiveness, optimality, equity, and legitimacy (Ibrahim, 2008). According to Hod et al. (2016), healthcare quality, actually has two main parts. First, technical quality means clinical that mainly focus on quantitative numbers and second is functional quality means quality related to services that focus on the process. Mohammad Mosadeghrad, (2013) defined healthcare quality as "*consistently delighting the patient by providing efficacious, effective and efficient healthcare services according to the latest clinical guidelines and standards, which meet the patients' needs and satisfies providers*". Mosadeghrad, (2014) identified 182 healthcare quality characteristics and clustered them into five groups: efficiency, environment, efficacy, empathy and effectiveness. Some of these characteristics include privacy, availability, attentiveness, accessibility, affordability, competency, acceptability, appropriateness, caring, timeliness, confidentiality, responsiveness, reliability, accountability, accuracy, continuity, comprehensiveness, equity, facilities and amenities.

Perceived quality is subjective in nature and thus is defined from patient's point of view. It is judgment of patients about the hospital's healthcare services. They make their judgments against the functional, technical, administrative and environmental qualities (Zeithaml, 1988). Patients are highly motivated to get best healthcare services and treatments. Thus, patients' perceptions can affect their choice about healthcare providers. Patients 'perception is an attitude which is closely related to satisfaction. Both the terms (perception and satisfaction) are used interchangeably in literature more often (Sitzia & Wood, 1997). Satisfaction is basically the fulfillment of patients' expectations, and is the difference between expectations and reality (Sofaer & Firminger, 2005). Researchers have revealed that the evaluation of patients' satisfaction is more sensitive and a reliable indicator than the traditional measures such as morbidity, mortality rates and physician peer review for measuring the performance healthcare system (Fitzpatrick, 1991).

Researchers have identified several determinants[48] of patient satisfaction in the literature. (Batbaatar, Dorjdagva, Luvsannyam, Savino, & Amenta, 2017) investigated numerous determinants of consumer's satisfaction in a systematic review and included the studies from various fields such as psychology, behavioral science, health management and marketing. Furthermore, the results of the studies vary within or across the fields. Though, other indicators of health service quality have positive impact on patients' satisfaction. Interpersonal care among the service indicators is the most significant predictor of patients' satisfaction. The socio-demographic characteristics of patient affect satisfaction's level but its direction and magnitude vary across fields.

Senarath et al., (2013) assessed the association between patients' satisfaction technical care such as ability, experience and competency of nursing staff. He also investigated the relationship between satisfaction and patients' characteristics for Sri Lankan hospitals and reported various findings for different variables of technical care. Bjertnaes et al., (2012) estimated different determinants of satisfaction. He collected the data from 63 hospitals of Norway in 2006 and applied multilevel regressions to access the determinants. According to findings of the study, the patients' experiences and fulfillment of expectations are related to patients' satisfaction. Andaleeb, (2001) is a patient-centered study and has identified important factors related to service quality from patient point of view. He examined the patient satisfaction in Bangladesh through a field survey and obtained patients' responses on assurance, communication, responsiveness, discipline and baksheesh. He found significant relationship between these factors and patients' satisfaction using multiple linear regression.

[48] Technical care, interpersonal care, physical environment, accessibility, affordability, availability, organizational characteristics, patient related characteristics, geographical characteristics, length of stay and expectations of the patients etc.

Some researchers have explored the geographical determinants of the satisfaction. (Atkinson & Haran, 2005) identified individual and district level determinants of satisfaction in the prospective of developing countries. He grouped individual determinants into socio-demographic and economic characteristics, healthcare provision, health outcome, and awareness in planning. Furthermore, potential determinants at district level are grouped as political culture, formal and informal organizations. He concluded that satisfaction is context specific local tool. DeVoe et al., (2007) has established the link between physicians and patients living and working in the same geographical area. He examined the patients' satisfaction correlations with physicians' career satisfaction with other correlates. According this study's findings, the satisfaction between patients and physicians were highly correlated living in the same area as compared to other healthcare service correlates.

Borghans et al., (2012) investigated patient's length of stay at hospitals, as a determinant of patients' satisfaction. He used data from seven specialties of Dutch hospitals such as internal medicine, pulmonology, cardiology, orthopedic surgery, neurology, obstetrics, general surgery, and gynecology for the period from 2003 to 2010. He found no association between length of stay and satisfaction in all the specialties except pulmonology. Hekkert et al., (2009) has determined the difference whether the variations in satisfaction level are attributed to patients, departments or hospitals. He did the analysis on fourteen general and eight academic Dutch hospitals in 2005. He found that patients' characteristics such as health status, education and age are more significant determinants of satisfaction as compared to hospital and department level characteristics.

In the literature of patients' perceptions, the association between performance evaluation and patients' satisfaction is the most ignorant area. There are few studies (Hod et al., 2016) that have examined the association between efficiency and satisfaction in health sector. The author has investigated the effect of service quality on the operational efficiency along with the other variables. The study included data from American Hospital Association, patients' satisfaction survey and centers of Medicaid and Medicare services. It found the significant relationship between quality of services and operational efficiency. The author further disaggregated the analysis for teaching and non-teaching hospitals. According to findings of the study, negative association (trade off) exists for non-teaching hospitals. On the contrary, positive for teaching hospitals.

There are many factors which can affect satisfaction of healthcare such as patients, hospital and geographical level. The hospital level factors can be further divided into many ways such as administrative, building, environment, attitude etc. All these factors are also very important in performance evaluation of a hospital. A hospital performance is usually measured taking number of patients treated as health outcome. The increase in efficiency of a hospital might affect the waiting time, consultation time, attitude of the providers and other staff etc. In turn, these all factors may affect the satisfaction level of patients. According to the literature (Ball, Murrells, Rafferty, Morrow, & Griffiths, 2013), number of staff have substantial association with health outcome. This study has examined the prevalence and nature of missed care by nurses in NHS (National Health Service) hospitals in England. He also investigated the association between staffing level with patients' outcome. According to the empirical findings, low nursing staff adversely affect patients' outcome.

Similarly, Needleman et al., (2011) has also showed the link between staffing and individual experience of patients. He used data of 197,961 admissions and 176,696 nursing shifts from 43 tertiary academics medical center. Cox Proportional Hazard models was used for this data analysis. He concluded a significant association between adverse health outcome and low nurse staffing.

One of the most important factor of patients' satisfaction depends on the attitude of the healthcare providers especially nurses because nurses interact with patients more often. Basically, satisfaction is the difference between perceived and expected services. When the patients' perceived exceed or equal to the expected services then they get satisfied and recommend these healthcare services to the others who need it (Samina et al., 2008). So, the attitude of the staff is very important in forming satisfaction level of the patients. Enhancement in technical efficiency might affect the attitude of the staff because per patient time will reduced with increase in number of patients. Therefore, which could adversely affect the perceptions of the patients.

Moreover, physician burnout is also a vital factor which might affect the patient's acceptability such as perceived quality, patients' satisfaction and communication (Dewa et al., 2017). Emotional exhaustion (EE) is one of the dimension of burnout[49] and (Maslach, Schaufeli, & Leiter, 2001) conceptualized EE as, "feelings of being overextended and depleted of one's emotional and physical resources". According to the literature, physician burnout not only affect their productivity such as job quitting and early retirement etc. but it may also affect entire healthcare system (Dewa et al., 2017; Klein, Grosse Frie, Blum, & von dem Knesebeck, 2010).

Klein et al., (2010) explored the association between quality of care and physician burnout for German hospitals. He used data of 1311 clinicians from 489 hospitals. He concluded that quality of care, well-being and health can be improved by reducing physicians' burnout.

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[49] The concept of physician burnout consist of three dimensions such as emotional exhaustion, depersonalization and low personal accomplishment. Depersonalization defined as "a negative, callous, or excessively detached response to various aspects" and low personal accomplishment is "it refers to feelings of incompetence and a lack of achievement and productivity at work".

Dewa et al., (2017) addressed the question, "how does physician burnout affect the quality of healthcare related to the dimensions of acceptability and safety?" in a systematic review. He focused on two dimensions of quality acceptability and safety. The review assessed 12 articles that fitted the inclusion criteria. Furthermore, the included studies assessed four types of quality measures (perceptions of patients, attitude or communication and patients' satisfaction for acceptability and medical errors) for safety. Three studies among four that has investigated association between patients' satisfaction and burnout showed a significant relationship (Anagnostopoulos et al., 2012; Halbesleben & Rathert, 2008; Ratanawongsa et al., 2008; Weng et al., 2011).

Efforts of performance enhancement by hospitals may lead to one of the component of physician burnout which in turn affects the patients' satisfaction. Effective communication between patients and physicians is the key to better health outcome, increased objective and subjective quality (J. Y. Chen et al., 2008). Clever, Jin, Levinson, & Meltzer, (2008) examined the association between patients' overall satisfaction and physician's behavior. He used administrative record and post discharge survey data for urban tertiary care hospitals from 1997 to 2000 using two step linear regression. He found positive relationship between communication and patients' satisfaction after controlling patient level factors.

The increasing emphasis on efficiency in healthcare service delivery could affect the valuable consultation time between patients and physician. Furthermore, the patients' satisfaction associated with healthcare activities are time intensive (Dugdale, Epstein, & Pantilat, 1999). According to few empirical studies (Like & Zyzanski, 1987; Morrell, Evans, Morris, & Roland, 1986; Ridsdale, Carruthers, Morris, & Ridsdale, 1989) patients who wished to spend more time with physician were not completely satisfied.

Hospitals are very resource intensive in nature. In order to streamline the rising cost of healthcare services, the most emphasis of healthcare care providers was on efficiency evaluation rather than on quality of the services. Subjective quality is an important factor in the process of hospital's production evaluation. Thus, patient satisfactions are subject to change with the increase or decrease in the level of efficiency of a hospital. There are numerous indirect channels through which the technical efficiency can affect the satisfaction level of patients. This chapter is an attempt to answer this important question and to explore the channels through which the efficiency of a hospital can affect the subjective quality of the services.

3.3 DATA AND VARIABLES AND ECONOMETRIC METHODOLOGY

This section is divided into two main subsections. The data and variables used in this chapter are discussed in first subsection and second consist of the information related to econometric methodology.

3.3.1 Data and Variables

Data for efficiency measurement, quality and patients' perceptions have been taken from survey of Health Facility Assessment (HFA). This survey was conducted by newborn, maternal and child health programme (NMCHP) supported by Technical Resource Facility (TRF) in the design and implementation across Pakistan from October 2010 to May 2011. It covers all of the regions and provinces of Pakistan with regards to NMCHP. To achieve the MDGs, Ministry of Health has established the national maternal newborn and child health programme (NMCHP) and the goal of this programme is to improve health status of newborns, mothers, and children. The health facility assessment aimed to explore the availability and functional level provided by health services in the public sector. This analysis was based on the availability of required inputs and assessment criteria in order to discover gaps between the availability and optimal level of inputs for human resources, infrastructure, equipment, drugs/supplies and level-specific support services.

For the purpose of this study, data from the Client Exit Interviews (CEIs) part of the HFA surveys is used. These aim towards collection of clients' perspective on the provided services. These perspectives are highly subjective and open to interpretation; however, they are equally important for improving the delivery of healthcare service quality. Preferred targets for CEIs are married women of child bearing age and fathers accompanying their children (under the age of 5), visiting the facility for MNCH related services. Main aim towards collection of this data is to capture patients' satisfaction by means of assessing their perceptions and expectations. The HFA collects this data for grades of hospitals. For the purpose of this study, data from only DHQHs has been used.

The data from District Head Quarter Hospitals (DHQHs) have been used for exploring the relationship between technical efficiency and patients' perceptions. The efficiency scores of all the DHQHs are measured using SFA and taken from second chapter.

Table 3.1 Descriptive Statistics of the Variables Used in the Index of Satisfaction

Variables	Very Satisfied	Satisfied	Not Satisfied	No responses	Total
Clinical examination	257	534	67	6	864
Communication	181	574	103	6	864
Attitude of the healthcare provider	196	597	63	8	864
Attitude of other staff	149	596	92	27	864

The above mentioned ordinal variables are used to form an index[50] for overall satisfaction. The variables contain the information about the satisfaction level of the patients related to clinical examination, communication which is "explanation about illness and course of treatment", attitude

[50] Three methods are used to form an index of overall satisfaction equal weights, Principal Component Analysis and Polychoric Principal Component Analysis.

of the healthcare provider and attitude of the other healthcare staff. The descriptive statistics for all the variables used in efficiency measurement are provided in the previous chapter (cross reference). The summary of technical efficiency scores according to level of satisfaction is provided in the table 3.2.

Table 3.2 Efficiency Scores According to the Level of Satisfaction

Satisfaction/Efficiency	Obs.	Mean	Std. Dev.	Min	Max
Very Satisfied	308	0.55	0.162	0.055	0.835
Satisfied	521	0.53	0.184	0.055	0.835
Not Satisfied	34	0.49	0.174	0.055	0.715

According to the descriptive analysis, more than 50 percent of the sample are satisfied and very satisfied. The following variables are used as determinants of patients' perception about a hospital. Usually, most of the services in the public hospitals of Pakistan are free. Whereas, patients have to pay for some. Thus, the question has asked whether they have paid any fees or not in the survey. Furthermore, as explanatory variables, whether medicines were prescribed by the physician, prescription of medicines, whether any tests were advised, whether patients were called for follow-up and whether the staff provided some educational material with regard to awareness are taken from Client Exit survey. These are all dummy variables takes the value 1 if the response of the patient is yes and 0 otherwise.

Table 3.3 Descriptive Statistics of the Explanatory Variables

Variables	No	Yes	Total
Paid Fee	187	677	864
Prescribed Medicines	116	748	864
Advised Tests	505	359	864
Follow Up	294	570	864
Provided Edu Material	779	85	864

3.3.2 Empirical Methodology

This section is divided into two parts. Efficiency scores are measured using SFA in the first section and relationship between efficiency and patients' opinion about the quality of services provided by public hospitals are estimated in the second section.

3.3.2.1 Efficiency Measurement with SFA

The Stochastic Production Frontier of Cobb Douglas form is given below;

$$lny_i = \alpha + ln(x_i')\beta_i + v_i - \mu_i$$

Where y_i represent the output of ith hospital, x_i' is the vector of inputs of ith hospital and $\beta_i$represent the vector of parameters. v_i, μ_i are two parts of error term with the following assumptions,

1. $v_i \sim iidN(0, \sigma_v^2)$
2. μ_i with exponential distribution
3. μ_i and v_i are independently distributed with each other and also with the regressor.

The symmetric error term v_i is the usual error term to allow for random factors like measurement errors, weather, strikes etc. The non-negative error term μ_i is the technical/allocative inefficiency component. Subscript i stand for ith hospital.

3.3.2.2 Relationship between Efficiency and Patients' Perceived Quality

The satisfaction level of a patient is a function of patients' characteristics, hospital characteristics and other variables such as geographical factors etc.

$$S_{ij} = f(TE_j, X_i, Y_j, Q_j, Z)$$

Where S_{ij} is the satisfaction level of patient i from hospital j , TE_j is the technical efficiency of hospital j , X_i is the characteristics of patient i , Y_j is the characteristics of hospital j, Q_j is the objective quality of a hospital and Z shows all other factors which can effect patients' satisfaction except patients and hospital characteristics.

$\partial S_{ij}/\partial TE_j \gtreqless 0$ & $\partial S_{ij}/\partial Q_j \gtreqless 0$ These are the required empirical questions. (Firstly, how technical efficiency and objective quality of a hospital, effects the satisfaction level of a patient and secondly, what are the channels through which efficiency can affect perceived quality)

To examine the association between patients' satisfaction, efficiency and objective quality, the study will use OLS and Ordered Logit regression technique according to the nature of dependent variable. Patients' satisfaction is considered as dependent variable and it is indexed under three different techniques for robustness such as equal weights, Principal Component Analysis (PCA) and Polychoric Principal Component Analysis (PPCA).

It remains as an ordinal variable in first case and classified into three categories including very satisfied, satisfied and not satisfied. Hence, Ordered Logit is an appropriate methodology to model the ordered categorical responses. Whereas, it becomes continues variable under PCA and PPCA, so one can think to use Ordinary Least Square (Olsen & Street) to estimate the model.

In Ordered Logit model, Y^* is latent variable (unobserved) and continues which can take any value between $(-\infty, \infty)$ and X is an ordinal (observed) variable and it is function of Y*. The latent variable is modeled as

$$y_i^* = x_i'\beta + u_i$$

Where x_i' the vector of the value i[th] predictor is, y_i^* is the i[th] value of a latent variable, β is the slope parameter and u_i is the error term. Let y_i, the realization variable of the latent variable y_i^*, assumes values j=1 …J. Let there be J-1 cut-points so that;

$$y_i = j \quad if\ \alpha_{j-1} < y_i^* \leq \alpha_j$$

Then the probability that observation *i* will choose category *j* is given by

$$p_{ij} = p(y_i = j) = p(\alpha_{j-1} < y_i^* \leq \alpha_j) = F(\alpha_j - x_i'\beta) - F(\alpha_{j-1} - x_i'\beta)$$

That is, the probability that $y_i = j$ is the probability that y_i^* takes the value between α_{j-1} and α_j. For the Ordered Logit, *F* is the logistic cdf with $F(z) = \frac{e^z}{1+e^z}$. The Ordered Logit with *J* categories will have one set of coefficients with (*J*-1) intercepts (cut-points). The signs of parameters show whether the latent variable increases with repressors. Hence, for interpretation we use odd ratios. An important underlying assumption in the ordered logistic regression is that the relationship between every category of outcome group is the same. To be exact, this model assumes that the coefficients that describe the relationship between, say, the lowest versus all higher categories of the dependent variable are the same as those that describe the relationship between the next lowest category and all higher categories. This is termed as the proportional odds assumption or the parallel regression assumption. Since same relationship is assumed between all pairs of categories, we obtain only one set of coefficients from regression.

To measure the association between perceived quality, efficiency and objective quality, we will use ordered Logit model and OLS using the following equation,

$$S_{ijk} = \alpha + \beta\, TE_j + \gamma Q_j + X_i'\sigma + Y_k'\delta + u_i$$

Where

- S_{ijk} is the satisfaction level of patient i from hospital j and District k,
- TE_j represent the technical efficiency of j^{th} hospital,
- X_i' is the vector of patient level control variables,
- Q_j represent the objective quality of hospital j,
- Y_k' is the vector of district level control variables,
- β is the parameter of efficiency,
- γ is the parameter of objective quality,
- σ is the vector of patient level control,
- δ is the vector of district level control variables and
- u_i is the error term with mean zero and constant variance (iid).

3.4 RESULTS AND DISCUSSION

This section contains three parts. The efficiency scores of all the DHQHs are discussed in the first part, followed by the process of index formation for the dependent variable (level of overall satisfaction) and the relationship between the patients' satisfaction, efficiency and objective quality is discussed in the last part.

3.4.1 Efficiency Measurement

The efficiency scores of all the DHQHs (public hospitals) are estimated using SFA in the previous chapter along with THQHs, RHCs and CHs. The summary of efficiency scores of all the hospitals is presented in the second chapter (cross reference) and their scores are provided in the appendix.

3.4.2 Techniques for Assigning Weights

In Client Exit Interviews (CEIs) under Health Facility Assessment many questions were asked to assess the patients' perspective for the services provided by public hospitals. An index of overall satisfaction is formed using the four ordinal satisfaction variables, for further exploration of the association between efficiency and overall satisfaction level of the patients.

There are various techniques used in the literature for assigning weights in index formation (Moser & Felton, 2007). These are data reduction methods; such that multivariate data can be represented by fewer dimensions. The choice of technique depends upon the nature of the original variables. Major techniques include Equal Weights, Principal Component Analysis (PCA), Factor Analysis (FA), Categorical Principal Component Analysis (CATPCA), Ordinal Principal Component Analysis (OPCA), Multiple Correspondence Analysis (MCA), Filmer–Pritchett Procedure and Polychoric Principal Component Analysis (PPCA). These all techniques are regression-based techniques except Equal Weights.

3.4.2.1 Equal weights

To be able to construct an index for overall satisfaction of the patients, few techniques have been applied and Equal Weights is one of them. According to the empirical evidence provided in the literature (Smits & Steendijk, 2015), Equal Weights method provides similar results as other techniques, such as PCA and FA. As the name suggests, it gives equal weights to all the original variables despite the importance of each variable. We have combined the four variables, such as satisfaction level of the patients related to clinical examination, communication which is "explanation about illness and course of treatment", the attitude of the healthcare provider and attitude of the other healthcare staff. We have assigned equal weights to all the original variables, in order to construct a single variable of overall patients' satisfaction. Whereas, assigning equal weights can be misleading, for example some patients can be very satisfied with clinical examination but not with others. So, we moved toward other techniques for relative weights, but we did the analysis using the variable constructed by Equal Weights for robust check.

3.4.2.2 Principal Component Analysis (PCA)

PCA is the most commonly used data reduction method. The main objective of this technique is to re-orient the multivariate data to summarize it into a fewer components or factors, that extract maximum information from the original variables. Linear combinations of the original observed variables are generated by means of orthogonal unobserved vectors or 'principal components'. This generates/assigns weights to observed variables based on their overall variability (proportional to their contribution).

The most initial step in PC analysis, is creating correlation matrix, as all of the analysis that follows is based on this table of bivariate correlations, called the correlation matrix. Most PCA procedures use only the Pearson correlation to calculate the first step. The assumption here is of normal distribution, which means that all variables have to be truly quantitative, symmetric, and bell shaped. While, the PCA can also be used for ordinal variables according to literature[51]. As the original variables of patients' satisfaction in this study are Likert Scale variables. So, this study has used PCA for constructing satisfaction index for robustness.

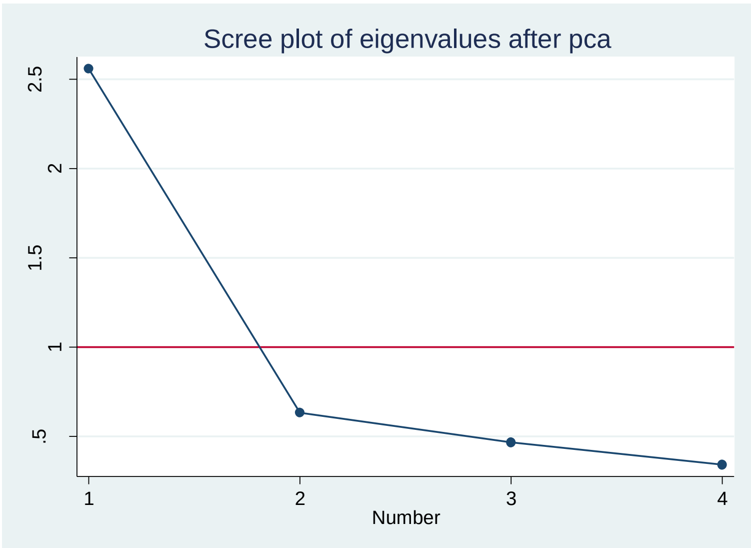
The first step in PCA method is to check correlation between the original variables, as the variables should be moderately correlated to each other. Otherwise the use of PCA will be pointless because the number of components will be same as the number of original variables. So, we have checked the correlation[52] between four variables related to satisfaction. The correlation ranges from 40 to 65 percent, which is a good indicator for using PCA. When we applied the PCA, we get eigen values which are the variances of the principal components. Once the components are

[51] Chapter: Principal Component Analysis, Statistics by Mathematics Learning Support Centre, Loughborough University.

[52] Results are provided in the appendix

calculated, then in the next step, the decision has to be made about the retaining of the principal components.

There are different methods which can be used to take decision. Firstly, choose sufficient principal components to with eigen value greater than 1. In this study, only one component has eigen value over 1. The scree plot indicates the cut-off between large and small eigen values. Only first component has eigenvalue more than 1, it means that first component explains the maximum variation in original variables which can be seen from the scree plot of the eigen values after PCA given in the following figure.



As per the Kaiser's rule, factors with eigen values λ exceeding unity are to be retained. Thus, any factor that is retained (z) should account for at least as much variation as any of the original variables (x). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, accounts for values between 0 and 1; where smaller values indicate that overall, the variables have little in common to warrant a principal components analysis. Thus, values above 0.5 are considered satisfactory for a principal components analysis.

Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	KMO
Examination	0.7472
Communication	0.7403
Provider Attitude	0.8059
Other staff Attitude	0.8201
Overall	0.7727

The results indicate that the overall and individual KMO values, of all the variables are almost greater than 70 percent. This shows a satisfactory use of PCA. Therefore, this study has constructed PCA using first component. As the nature of variables which need to be combined is ordinal in this study. So, according to some literature, standard PCA technique is unsatisfactory, as it is designed for normally distributed and continuous variables (Kolenikov & Angeles, 2004). Therefore, Polychoric Principal Analysis has also been applied.

3.4.2.3 Polychoric Principal Component Analysis (PPCA)

As a limitation mentioned earlier regarding the standard PCA, Kolenikov & Angeles (2004) designed the PPCA specifically for categorical variables as an improvement on PCA. This new technique offers many advantages over classical PCA (Moser & Felton, 2007). For standard/classical PCA, the assumption of normal distribution must hold true, as the matrix comprises of Pearson correlations only. PPCA correlation matrix comprises of Polychoric, Polyserial and Pearson correlations and thus normal distribution is not a concern. Coefficients of PPCA are more accurately estimated compared to standard PCA.

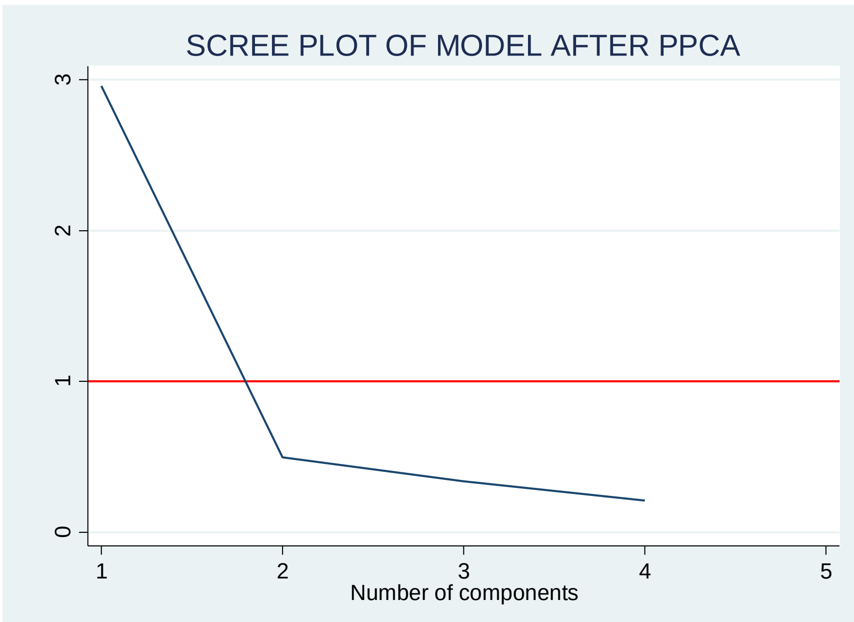
Furthermore, PPCA avoids spurious correlations generated by Filmer–Pritchett procedure, and can be utilized for both discrete and continuous data types at a time unlike MCA which handles only discrete data (Moser & Felton, 2007). Other advantages of the PPCA include its specific assignment of weights. These are assigned to each value and/or order of values for discrete and ordinal variables respectively, followed by its coefficients. It also permits calculation of coefficients in case of not possessing as asset. This is highly informative as at times, not having something also conveys useful information (Moser & Felton, 2007). In addition to above mentioned advantages, PPCA is the only method that correctly reports proportion of explained variance (Kolenikov & Angeles, 2004) .

In Polychoric PCA, maximum likelihood is used to calculate how the continuous variable (observed values of an underlying continuous variable is assumed for the discrete data) would split in order to produce observed values. Variables can either be binary, ordinal or continuous, but cannot be nominal. The correlations in the matrix generated in this technique are not just Polychoric correlations. In cases of multivariate (more than two variables), the estimated overall correlation matrix is constructed by combining the pairwise estimates of the polychoric, polyserial, or Pearson correlations. A polychoric correlation and Pearson's correlation are calculated when both variables are ether ordinal or continuous respectively. When there is mixture of ordinal and continuous, a polyserial correlation is calculated. Polychoric and polyserial correlations assume maximum likelihood estimates of the correlation between the unobserved normally distributed continuous variables and the discrete variables and thus they differ from correlation coefficients for continuous variables (Kolenikov & Angeles, 2009). After this initial step of generating matrix, PCA is performed using the matrix as an input rather than raw variables.

When the technique of PPCA is applied, firstly the Polychoric Correlation Matrix is obtained[53]. According to the results of this study, the correlation ranges from 55 to 79 percent which is very high (which shows the appropriate use of PPCA). Secondly, PPCA calculates Eigen values which are the variances of the principal components. In the next step, the decision has to be

[53] The Polychoric Correlation Matrix is provided in the appendix.

made about the retaining of the principal components. There are different methods which can be used for this purpose. Firstly, to choose components with Eigen value greater than 1. In this study, only one component has Eigen value over 1. The scree plot indicate that there is a cut-off between large and small Eigen values. In this case only first component has Eigen value above 1 which can be seen in the following scree plot. So, we will retain first component for further analysis.



3.4.3 Association between Efficiency and patients' satisfaction

In the process of hospital's production evaluation, subjective quality is an important factor. Often in the literature, patients' satisfaction is an indicator of their perceptions, and defined as patient's reaction to healthcare services. The correlation of satisfaction, efficiency and objective quality is calculated for three different indices (variables) of satisfaction. While, the correlation for all the cases is negative and its magnitude is almost similar (around 10 percent). This indicates that with the increase of hospital efficiency, the patients' satisfaction tends to decrease. Also, the correlation of satisfaction and number of deaths, is negative for all the cases with almost same magnitude (6 to 11 percent). Which indicates that the subjective quality of a hospital is positively related to the objective quality.

The impact of technical efficiency of a hospital on the patients' satisfaction has been analyzed in this chapter. Thus, in this analysis, dependent variable is level of satisfaction, which is constructed via three different methods for robustness. To achieve the objective, different models are estimated, taking satisfaction index (under equal weights, PCA and PPCA) as dependent variable.

3.4.3.1 Ordered Logistic Regressions (Equal Weights)

Three different models are estimated accounting for patients' satisfaction constructed under equal weights as dependent variable. Model 1 captures the exclusive effect of efficiency and number of deaths on level of satisfaction. Whereas, patients and district level variables are controlled in Model2 and Model 3 respectively.

The results estimate a negative association between hospital efficiency and patients' perceptions, as the coefficient of the efficiency is negative and highly significant in all the models. Moreover, the coefficient of the indicator used for objective quality (number of deaths) is also negative and highly significant (p value less than 0.001 in all models). It means that objective quality has positive association with the patients' satisfaction. Previous empirical researchers have also found positive association between satisfaction (subjective quality) and objective quality (Batbaatar et al., 2017; Schaal, Schoenfelder, Klewer, & Kugler, 2017; Wisniewski, Diana, Yeager, & Hotchkiss, 2018). However, according to findings of Hod et al. (2016), negative association (trade off) between operational efficiency and patients' satisfaction exists for non-teaching hospitals. Since coefficients of Ordered Logit regression cannot be directly interpreted, therefore, odd ratios are also estimated.

Table 3.4 Results of Ordered Logit Regressions

	Model 1		Model 2		Model 3	
VARIABLES	coefficients	Odds ratio	Coefficients	Odds ratio	Coefficients	Odds ratio
Efficiency	-1.465***	0.231***	-1.547***	0.213***	-1.247***	0.287***
	(0.448)	(0.103)	(0.454)	(0.0967)	(0.469)	(0.135)
Deaths	-0.00573***	0.994***	-0.00649***	0.994***	-0.00649***	0.994***
	(0.00175)	(0.00174)	(0.00179)	(0.00178)	(0.00184)	(0.00183)
Age			0.0145	1.015	0.0149*	1.015*
			(0.00889)	(0.00902)	(0.00892)	(0.00906)
Fees paid			-0.0608	0.941	-0.0116	0.989
			(0.175)	(0.164)	(0.193)	(0.191)
Prescribed medicines			-0.128	0.880	-0.115	0.891
			(0.215)	(0.189)	(0.216)	(0.192)
Advised test			-0.395***	0.674***	-0.435***	0.647***
			(0.150)	(0.101)	(0.151)	(0.0980)
Follow up			-0.418**	0.659**	-0.323*	0.724*
			(0.162)	(0.107)	(0.166)	(0.120)
Education material			-0.0710	0.931	-0.0234	0.977
			(0.239)	(0.223)	(0.242)	(0.237)
Waiting time			0.146	1.157	0.202**	1.224**
			(0.0982)	(0.114)	(0.101)	(0.123)
Gender			-0.123	0.884	-0.0982	0.906
			(0.221)	(0.196)	(0.226)	(0.205)
Population					0.0843	1.088
					(0.0671)	(0.0730)
Literacy rate					-0.0188**	0.981**
					(0.00757)	(0.00743)
HDI					-0.412	0.662
					(1.459)	(0.967)
Constant cut1	-1.511***	0.221***	-1.766***	0.171***	-2.304***	0.0998***
	(0.272)	(0.0600)	(0.644)	(0.110)	(0.745)	(0.0743)
Constant cut2	2.323***	10.20***	2.145***	8.546***	1.642**	5.163**
	(0.301)	(3.075)	(0.656)	(5.607)	(0.751)	(3.879)
Diagnostics						
Pseudo R^2	0.0155	0.0155	0.0339	0.0339	0.0421	0.0421
LR-chi^2	21.42***	21.42***	46.77***	46.77***	58.08***	58.08***
Log likelihood	-679.51	-679.51	-666.84	-666.84	-661.19	-661.19
Observations	863	863	863	863	863	863
No of Hospitals (Districts)	84	84	84	84	84	84

Note: Standard errors in parentheses, * p<0.05, ** p<0.01, *** p<0.001, ***, **, * shows significance at 1 percent, 5 percent and 10 percent respectively

According to the odd ratios, with every one unit increase in efficiency of a hospital that is going from 0 to 1, the odds of very satisfied versus combined satisfied and no satisfied categories are 0.231 lower, given that all of the other variables in the model are held constant. Likewise, the odds of the combined very satisfied and satisfied categories versus not satisfied is 0.231 times lower given that all of the other variables in the model are held constant for Model 1. However, the odds ratio of the other two models are also similar approximately.

Among the other explanatory variables, only follow-up and advised test are significant and have negative effect on patient satisfaction. In most cases, public hospitals of Pakistan offer free consultation, and patients are required to only pay for medications and diagnostics. Given the relatively economical aspect of public hospitals, the usual waiting time is very high and thus, patients are already aware and mentally prepared in this regard. The time is the opportunity cost in going to public hospitals. Thus, the effect of waiting time is insignificant according to the results. However, considering patients are required to pay for diagnostics at every visit, follow-up and advised test have negative effect on the level of satisfaction.

The analysis show that among the district level explanatory variables, literacy rate is a significant predictor of patient satisfaction. This can be estimated as its coefficient is negative, with a significant p value. Thus, it can be said that a literate person is less likely satisfied compared to an illiterate person due to higher level of education which is directly proportional to awareness.

The problem of simultaneity can be arise between quality and efficiency, as efficiency can be said as an endogenous variable. The causal relationship between these two variables can be exists. Furthermore, Hospitals that have economic pressure due to bad reputation (low level of patients' satisfaction) are forced to increase their technical efficiency. So, the undetermined causal direction is the problem of endogeniety. 2SRI technique is used to tackle the problem of endogeniety, and results are displayed in the table 3.5.

Table 3.5 Results of 2SRI with Bootstrapping

VARIABLES	Model 1	Model 2	Model 3	Model 4 (P)	Model 5 (D)
Efficiency	-1.147***	-1.110***	-0.922**	-0.984**	-31.73*
	(0.421)	(0.426)	(0.436)	(0.468)	(17.89)
Deaths	-0.00592***	-0.00591***	-0.00594***	-0.00583***	-0.716***
	(0.00166)	(0.00167)	(0.00171)	(0.00173)	(0.257)
Fees Paid	----	-0.101	-0.0517	0.0806	0.588
		(0.163)	(0.193)	(0.233)	(0.465)
Medicine Available	----	0.00475	-0.0202	-0.0864	-0.335**
		(0.0993)	(0.101)	(0.105)	(0.171)
Edu Material	----	-0.191	-0.134	-0.00280	0.678
		(0.241)	(0.245)	(0.247)	(0.455)
Waiting Time	----	0.117	0.178*	0.182*	0.189
		(0.0990)	(0.104)	(0.109)	(0.181)
Age	----	0.0135	0.0143*	0.0156*	0.0231
		(0.00859)	(0.00862)	(0.00868)	(0.0149)
Gender	----	-0.179	-0.148	-0.148	0.0681
		(0.237)	(0.238)	(0.242)	(0.368)
Population	----	----	0.0802	0.0125	-3.625***
			(0.0805)	(0.0860)	(1.108)
Literacy rate	----	----	-0.0222***	-0.0232***	0.117
			(0.00823)	(0.00866)	(0.167)
HDI	----	----	-0.180	-0.377	43.38
			(1.714)	(2.007)	(45.68)
Xuhat	55.53	44.15	15.52	23.11	127.6
	(74.64)	(76.57)	(79.77)	(80.41)	(106.8)
Observations	863	863	863	863	863
No of Hospitals	84	84	84	84	84

Bootstrapped Standard errors in parentheses and *** p<0.01, ** p<0.05, * p<0.1, ***, **, * shows significance at 1 percent, 5 percent and 10 percent respectively

The relationship between efficiency and level of satisfaction is estimated without any control variables in model 1. Hospital level and district level variables are controlled in model 2 and 3 respectively for heterogeneity analysis. Province level fixed effects and District level fixed effects are captured in model 4 and 5 respectively.

According to the results, the coefficient of efficiency is negative and highly significant in all the models. Results of 2SRI are in line with the results of other models used in the analysis and the residual (Xuhat) obtained from first stage regression is insignificant which indicates the exogeneity of technical efficiency. If the residual has been have a significant effect on level of satisfaction, we could be able to treat efficiency as endogenous regressor. The results of 2SRI are bootstrapped to correct the standard errors.

For sensitivity analysis the same analysis has been done using the satisfaction index constructed under principal component analysis and Polychoric principal component analysis.

3.4.3.2 Sensitivity Analysis (PCA & PPCA)

The previous analysis incorporates satisfaction index constructed by means of equal weights to all original variables. So, similar analysis has been performed with PCA and PPCA for sensitivity analysis.

The original variables are ordinal, so according to some literature PCA is not an appropriate technique. Reason being, PCA is based on Pearson correlation and it follows the normality assumption. Thus, Polychoric PCA has also been applied for robustness. As part of the technique (PCA and PPCA), the dependent variable (level of satisfaction) constructed is transformed into a continuous variable. Therefore, OLS regression has been used for exploring the impact of efficiency and objective quality on level of satisfaction in both methods. Six models have been estimated in this subsection, three for each case. The exclusive impact of efficiency and number of deaths is explored in Model 1 and Model 4 under PCA and PPCA respectively. Whereas, the patient level and district level effects have been captured in remaining models for the variable constructed under both the techniques. The results of all the models are almost similar with the previous regressions. The efficiency of a hospital and number of deaths in a hospital have a negative and significant impact on patients' satisfaction.

Table 3.6 Sensitivity Analysis

Variables	PCA			Polychoric PCA		
	Model1	Model2	Model3	Model4	Model5	Model6
Efficiency	-0.795**	-0.846**	-0.782*	-0.702**	-0.745**	-0.677*
	(0.307)	(0.303)	(0.306)	(0.268)	(0.264)	(0.266)
Deaths	-0.00288*	-0.00329*	-0.00318*	-0.00243*	-0.00280*	-0.00271*
	(0.00130)	(0.00129)	(0.00129)	(0.00113)	(0.00112)	(0.00112)
Fees Paid	----	0.0463	0.0212		0.0197	0.0145
		(0.132)	(0.143)		(0.115)	(0.125)
Prescribed Medicines	----	-0.323*	-0.315*		-0.278*	-0.269
		(0.158)	(0.158)		(0.138)	(0.138)
Advised Test	----	-0.265*	-0.273*		-0.221*	-0.231*
		(0.113)	(0.114)		(0.0987)	(0.0992)
Follow-up	----	-0.513***	-0.477***		-0.453***	-0.415***
		(0.120)	(0.122)		(0.105)	(0.106)
Edu Material	----	0.111	0.165		0.0877	0.127
		(0.186)	(0.187)		(0.162)	(0.163)
Waiting Time	----	0.146*	0.177*		0.124	0.150*
		(0.0742)	(0.0756)		(0.0647)	(0.0659)
Age	----	0.0123	0.0123		0.0104	0.0104
		(0.00663)	(0.00662)		(0.00578)	(0.00577)
Gender	----	-0.131	-0.150		-0.124	-0.126
		(0.166)	(0.168)		(0.145)	(0.147)
Population	----	----	0.0865		----	0.0601
			(0.0493)			(0.0429)
Literacy Rate	----	----	-0.0108		----	-0.00980*
			(0.00558)			(0.00486)
HDI	----	----	0.0976		----	0.0704
			(1.077)			(0.939)
Constant	0.463**	0.828	1.103*	0.403**	0.767	1.004*
	(0.175)	(0.474)	(0.552)	(0.152)	(0.413)	(0.482)
Observations	863	863	863	863	863	863
No of Hospitals	84	84	84	84	84	84

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ***, **, * shows significance at 1 percent, 5 percent and 10 percent respectively

The explanatory variables have also similar trend, magnitude and significance as compared to the results of earlier regressions. To further explore the channels through which efficiency might affect the level of satisfaction, the disaggregated analysis has also been performed. The dimensions through which the efforts to enhance the technical efficiency of hospitals might affect the satisfaction of the people is explored. Whether the efficiency enhancement efforts affect the satisfaction level gained from the attitude of the provider or from the clinical examination? Due to this kind of queries, disaggregated analysis has been performed.

3.4.3.3 Disaggregated Analysis

The disaggregated analysis is carried out for four variables of satisfaction, which have been used in the construction of the satisfaction index. To further explore the channels through which the efficiency of a hospital may affect the patients' satisfaction, the following analysis has been carried out.

Physician's attitude might be more affected by efficiency enhancement efforts, as this may lead to physician burnout. The results of table 3.7 reveal that hospital efficiency is negatively associated with the level of satisfaction in relation to healthcare provider's attitude, as the coefficients are negative, and both the coefficient and odd ratios are highly significant. According to the odd ratios, with every one unit increase in efficiency of a hospital, the odds of very satisfied versus combined satisfied and no satisfied categories are 0.159 lower, given that all of the other variables in the model are held constant. Likewise, the odds of the combined very satisfied and satisfied categories versus not satisfied is 0.159 times lower given that all of the other variables in the model are held constant for Model 1. However, the odds ratio of the other two models are also similar approximately. Previous literature also explain that, physician burnout is also a vital factor which might affect perceived quality of the patients (Clever et al., 2008; Dewa et al., 2017).

Table 3.7 Level of satisfaction (attitude of healthcare provider)

Variables	Model 1		Model 2		Model 3	
	Coefficients	Odds ratio	Coefficients	Odds ratio	Coefficients	Odds ratio
Efficiency	-1.836***	0.159***	-1.967***	0.140***	-1.762***	0.172***
	(0.474)	(0.0755)	(0.482)	(0.0674)	(0.498)	(0.0856)
Deaths	-0.00162	0.998	-0.00237	0.998	-0.00202	0.998
	(0.00169)	(0.00168)	(0.00173)	(0.00173)	(0.00175)	(0.00174)
Age	----	----	0.0224**	1.023**	0.0229**	1.023**
			(0.00916)	(0.00936)	(0.00922)	(0.00943)
Fees paid	----	----	-0.0527	0.949	-0.0585	0.943
			(0.182)	(0.172)	(0.201)	(0.189)
Prescribed medicines	----	----	-0.114	0.892	-0.140	0.869
			(0.223)	(0.199)	(0.225)	(0.196)
Advised test	----	----	-0.131	0.877	-0.164	0.849
			(0.156)	(0.137)	(0.158)	(0.134)
Follow up	----	----	-0.650***	0.522***	-0.578***	0.561***
			(0.172)	(0.0898)	(0.175)	(0.0984)
Education material	----	----	0.143	1.153	0.257	1.293
			(0.249)	(0.287)	(0.253)	(0.328)
Waiting time	----	----	-0.0853	0.918	0.0118	1.012
			(0.103)	(0.0943)	(0.106)	(0.107)
Gender	----	----	0.0746	1.077	-0.00611	0.994
			(0.229)	(0.247)	(0.234)	(0.233)
Population	----	----	----	----	0.293***	1.341***
					(0.0714)	(0.0958)
Literacy rate	----	----	----	----	-0.0167**	0.983**
					(0.00785)	(0.00772)
HDI	----	----	----	----	-2.200	0.111
					(1.526)	(0.169)
Constant cut1	-2.316***	0.0987***	-2.385***	0.0921***	-3.661***	0.0257***
	(0.294)	(0.0290)	(0.672)	(0.0619)	(0.784)	(0.0202)
Constant cut2	1.398***	4.046***	1.428**	4.172**	0.235	1.264
	(0.284)	(1.150)	(0.668)	(2.787)	(0.770)	(0.974)
Diagnostics						
Pseudo R^2	0.0116	0.0116	0.0304	0.0304	0.0466	0.0466
LR-chi^2	15.99***	15.99***	41.68***	41.68***	63.97***	63.97***
Log likelihood	-678.36	-678.36	-665.51	-665.51	-654.37	-654.37
Observations	863	863	863	863	863	863
No of Hospitals	84	84	84	84	84	84

Note: Standard errors in parentheses, * p<0.05, ** p<0.01, *** p<0.001, ***, **, * shows significance at 1 percent, 5 percent and 10 percent respectively

The results of regressions of table 3.8 reveal that the efficiency of a hospital has negative effect on patient satisfaction, achieved through the explanation about illness and course of treatment, as the coefficient of the efficiency is negative and significant. Our results are in line with the previous literature (J. Y. Chen et al., 2008) .

Table 3.8 Level of Satisfaction (Explanation about Illness and Course of Treatment)

VARIABLES	Model 1		Model 2		Model 3	
	Coefficients	Odds ratio	Coefficients	Coefficients	Odds ratio	Coefficients
Efficiency	-1.162***	0.313***	-1.215***	0.297***	-1.108**	0.330**
	(0.446)	(0.140)	(0.454)	(0.135)	(0.467)	(0.154)
Deaths	-0.00397**	0.996**	-0.00467***	0.995***	-0.00482***	0.995***
	(0.00162)	(0.00161)	(0.00166)	(0.00166)	(0.00167)	(0.00166)
Age	----	----	0.0111	1.011	0.0118	1.012
			(0.00905)	(0.00915)	(0.00906)	(0.00917)
Fees paid	----	----	-0.143	0.866	-0.163	0.849
			(0.175)	(0.152)	(0.192)	(0.163)
Prescribed medicines	----	----	-0.275	0.759	-0.243	0.784
			(0.216)	(0.164)	(0.217)	(0.170)
Advised test	----	----	-0.196	0.822	-0.199	0.820
			(0.153)	(0.126)	(0.154)	(0.126)
Follow up	----	----	-0.786***	0.456***	-0.738***	0.478***
			(0.167)	(0.0763)	(0.170)	(0.0815)
Education material	----	----	0.285	1.330	0.281	1.324
			(0.249)	(0.331)	(0.252)	(0.334)
Waiting time	----	----	0.198*	1.220*	0.189*	1.209*
			(0.102)	(0.124)	(0.104)	(0.126)
Gender	----	----	-0.194	0.824	-0.135	0.873
			(0.222)	(0.183)	(0.226)	(0.197)
Population	----	----	----	----	-0.110	0.896
					(0.0672)	(0.0602)
Literacy rate	----	----	----	----	-0.0131*	0.987*
					(0.00764)	(0.00754)
HDI	----	----	----	----	2.345	10.44
					(1.490)	(15.55)
Constant cut1	-2.055***	0.128***	-2.802***	0.0607***	-2.275***	0.103***
	(0.275)	(0.0352)	(0.650)	(0.0395)	(0.750)	(0.0771)
Constant cut2	1.253***	3.501***	0.635	1.888	1.184	3.268
	(0.267)	(0.935)	(0.640)	(1.209)	(0.746)	(2.438)
Diagnostics						
Pseudo R^2	0.0081	0.0081	0.0330	0.0330	0.0373	0.0373
LR-chi^2	12.05***	12.05***	48.91***	48.91***	55.33***	55.33***
Log likelihood	-735.20	-735.20	-716.78	-716.78	-713.57	-713.57
Observations	863	863	863	863	863	863
No of Hospitals	84	84	84	84	84	84

Note: Standard errors in parentheses, * p<0.05, ** p<0.01, *** p<0.001, ***, **, * shows significance at 1 percent, 5 percent and 10 percent respectively

According to Dugdale et al. (1999) patients' satisfaction level linked with healthcare activities is time concentrated.

Table 3.9 Level of Satisfaction (Clinical Examination)

VARIABLES	Model 1		Model 2		Model 3	
	Coefficients	odds ratio	Coefficients	odds ratio	Coefficients	odds ratio
Efficiency	-0.857**	0.425**	-0.855*	0.425*	-0.440	0.644
	(0.436)	(0.185)	(0.444)	(0.189)	(0.461)	(0.297)
Deaths	-0.00383**	0.996**	-0.00429***	0.996***	-0.00430**	0.996**
	(0.00162)	(0.00161)	(0.00165)	(0.00165)	(0.00168)	(0.00167)
Age	----	----	0.0132	1.013	0.0142	1.014
			(0.00869)	(0.00880)	(0.00875)	(0.00887)
Fees paid	----	----	-0.172	0.842	-0.0325	0.968
			(0.172)	(0.145)	(0.189)	(0.183)
Prescribed medicines	----	----	-0.334	0.716	-0.307	0.736
			(0.214)	(0.153)	(0.215)	(0.158)
Advised test	----	----	-0.378**	0.685**	-0.433***	0.649***
			(0.150)	(0.103)	(0.152)	(0.0984)
Follow up	----	----	-0.457***	0.633***	-0.333**	0.717**
			(0.162)	(0.102)	(0.165)	(0.118)
Education material	----	----	-0.0370	0.964	-0.0720	0.931
			(0.238)	(0.229)	(0.241)	(0.225)
Waiting time	----	----	0.333***	1.396***	0.360***	1.434***
			(0.0990)	(0.138)	(0.101)	(0.145)
Gender	----	----	-0.289	0.749	-0.149	0.862
			(0.221)	(0.165)	(0.226)	(0.194)
Population	----	----	----	----	-0.107	0.899
					(0.0653)	(0.0587)
Literacy rate	----	----	----	----	-0.0184**	0.982**
					(0.00741)	(0.00727)
HDI	----	----	----	----	0.469	1.598
					(1.444)	(2.308)
Constant cut1	-1.402***	0.246***	-1.963***	0.140***	-2.003***	0.135***
	(0.263)	(0.0649)	(0.634)	(0.0890)	(0.733)	(0.0989)
Constant cut2	1.875***	6.520***	1.432**	4.185**	1.449**	4.261**
	(0.272)	(1.775)	(0.633)	(2.651)	(0.732)	(3.120)
Diagnostics						
Pseudo R^2	0.0060	0.0060	0.0315	0.0315	0.0446	0.0446
LR-chi^2	8.99***	8.99***	46.99***	46.99***	66.61***	66.61***
Log likelihood	-741.98	-741.98	-722.98	-722.98	-713.17	-713.17
Observations	863	863	863	863	863	863
No of Hospitals	84	84	84	84	84	84

Note: Standard errors in parentheses, * p<0.05, ** p<0.01, *** p<0.001, ***, **, * shows significance at 1 percent, 5 percent and 10 percent respectively

According to few empirical studies (Like & Zyzanski, 1987; Morrell et al., 1986; Ridsdale et al., 1989) patients who prefer spending more time during consultations, are less likely satisfied. It means that the consultation time has a positive impact on the patients' satisfaction which might be adversely affected by the efficiency enhancement efforts.

Table 3.10 Level of satisfaction (Other Staff Attitude)

VARIABLES	Model 1		Model 2		Model 3	
	Coefficients	odds ratio	Coefficients	odds ratio	Coefficients	odds ratio
Efficiency	-0.391	0.676	-0.498	0.608	-0.674	0.510
	(0.458)	(0.310)	(0.464)	(0.282)	(0.478)	(0.244)
Deaths	-0.00105	0.999	-0.00153	0.998	-0.00145	0.999
	(0.00167)	(0.00167)	(0.00168)	(0.00168)	(0.00170)	(0.00169)
Age	----	----	0.00471	1.005	0.00457	1.005
			(0.00901)	(0.00905)	(0.00903)	(0.00907)
Fees paid	----	----	0.318*	1.374*	0.180	1.197
			(0.177)	(0.243)	(0.194)	(0.232)
Prescribed medicines	----	----	-0.567***	0.567***	-0.583***	0.558***
			(0.218)	(0.124)	(0.218)	(0.122)
Advised test	----	----	-0.166	0.847	-0.141	0.869
			(0.156)	(0.132)	(0.157)	(0.136)
Follow up	----	----	-0.563***	0.570***	-0.591***	0.554***
			(0.168)	(0.0959)	(0.172)	(0.0952)
Education material	----	----	-0.175	0.839	-0.0950	0.909
			(0.248)	(0.208)	(0.251)	(0.228)
Waiting time	----	----	0.111	1.117	0.136	1.145
			(0.103)	(0.115)	(0.105)	(0.120)
Gender	----	----	-0.155	0.856	-0.271	0.763
			(0.228)	(0.195)	(0.232)	(0.177)
Population	----	----	----	----	0.167**	1.181**
					(0.0688)	(0.0813)
Literacy rate	----	----	----	----	-0.00328	0.997
					(0.00764)	(0.00762)
HDI	----	----	----	----	0.241	1.272
					(1.502)	(1.911)
Constant cut1	-1.804***	0.165***	-2.604***	0.0739***	-2.834***	0.0588***
	(0.279)	(0.0459)	(0.658)	(0.0486)	(0.767)	(0.0451)
Constant cut2	1.609***	4.999***	0.919	2.507	0.719	2.051
	(0.276)	(1.382)	(0.649)	(1.628)	(0.758)	(1.556)
Diagnostics						
Pseudo R^2	0.0007	0.0007	0.0214	0.0214	0.0272	0.0272
LR-chi^2	1.06	1.06	30.76***	30.76***	39.04***	39.04***
Log likelihood	-716.59	-716.59	-701.75	-701.75	-697.61	-697.61
Observations	863	863	863	863	863	863
No of hospitals	84	84	84	84	84	84

Note: Standard errors in parentheses, * p<0.05, ** p<0.01, *** p<0.001.

Like all the results of above models, the number of deaths has negative effect on the level of satisfaction associated with the explanation about the illness and treatment. The results of the explanatory variables are also similar.

The results of Model 1 and Model 2 (Table 3.9) reveal that hospital efficiency has negative effect on the level of the satisfaction with respect to clinical examination, as the coefficients and odd ratios are significant. Moreover, the findings of all other explanatory variables are similar.

Table 3.10 explains the effect of efficiency on the patients' satisfaction associated with the attitude of the other staff in the hospital. According to the empirical findings the coefficients of efficiency in all the models are not significant. It means that the technical efficiency has no effect on patients' satisfaction in this regard. Patient satisfaction associated with the attitude of the physician is more likely to be affected by the hospital's efficiency as compared to the satisfaction associated with other staff attitude.

3.5 CONCLUDING REMARKS

This chapter has explored whether the efficiency enhancement efforts actually affect patients' satisfaction. This affect is explored for all the DHQ hospitals of Pakistan. The technical efficiency scores of all the public hospitals estimated in the previous chapter using stochastic frontier analysis are used for further exploration in this chapter. To achieve the objective of this study, 2SRI, LSDV, Ordered Logistic Regression and Ordinary Least Square techniques are used.

The data on patient's perceptions' and other control variables are taken from Client Exit Interviews that was part of HFA survey. The aim of these interviews was to collect the client perspective on provided services from the hospitals. The target individuals for CEIs were married women of child bearing age and fathers accompanying the children under the age of 5 years, visiting the facility for MNCH related services.

The main variable of analysis is overall satisfaction and four ordinal variables are used to form index of satisfaction. These variables contain the information related to patients' satisfaction about the clinical examination, explanation about illness and course of treatment, attitude of the healthcare provider and attitude of the other staff. Three techniques are used to form satisfaction index such as equal weights, Principal Component Analysis and Polychoric Principal Component Analysis for robustness.

Pearson correlation of satisfaction (subjective quality), objective quality (number of maternal and neonatal deaths) and technical efficiency are measured for three different indices. According to the findings, the correlation between satisfaction and efficiency is negative for all the indices of satisfaction and correlation between objective quality and satisfaction is positive. As the dependent variable "overall satisfaction" becomes continuous under PCA and PPCA, so OLS is used. Furthermore, Ordered Logistic Regression is used for the variable constructed under equal weights. According to the regressions' findings, negative association exists between efficiency and patients' perceptions which indicates that with the increase in hospital efficiency, the satisfaction level of the patients tends to decrease. As we have three indices of satisfaction for robustness and we have found same results for all the regressions.

To further explore the channels through which the patients' perceptions might be affected by hospitals' efficiency, the disaggregated analysis has been performed for four ordinal variables related to satisfaction. According to the findings, patients' satisfaction which is associated with the healthcare provider attitude, with explanation about the illness & course of treatment and clinical examination is more affected by the technical efficiency as compared to other staff attitude.

Enhancement in technical efficiency might affect the attitude of the healthcare provider because per patient time will reduced with increase in number of patients and physicians will be exhausted (It means doctors has to treat more patients in a given time period). Consequently, it could adversely affect the satisfaction level of the patients. Efforts to increase technical efficiency could leads to physicians' burnout which in turn affect quality of care including patients' perceptions, wellbeing and health Dewa et al., (2017).

Thus, it can be said that hospital efficiency and patient satisfaction are more sensitive to physician's (healthcare provider) attitude, examination, communication and the consultation time. This can be held true, as from a patient's perspective, longer the consultation time, better and more accurate diagnosis is achieved. The same can be said about physician's attitude. A comforting and confident physician is likely to achieve better patient satisfaction.

However, to avoid the extreme situations, there should be threshold level for consultation time. Firstly, the stretched consultations time leads to inefficiencies which could further harm the health system and secondly, short consultation time with the healthcare provider may affect the patients' satisfaction level. Thus, a nonlinear relation exist between efficiency of a hospital and patients' satisfaction.

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CONCLUSION

The three chapters present comprehensive analysis regarding the technical efficiency and quality indicators of public and private hospitals of Pakistan. Low technical efficiency scores are estimated for all the private hospitals. It is found that not a single hospital is working on full efficient level. Therefore, all the private hospitals can increase their output level using the same level of resources. The positive spillover effects are observed for outpatients care in small hospitals and for inpatients care in big hospitals. Hence, behavior of private hospitals is not similar towards outpatients and inpatients.

` According to the empirical literature, the size of the hospital has real impact on the final health outcome (Giancotti, Guglielmo et al. 2017). As the small hospitals specialized in ambulatory care and big hospitals in inpatients care to compete with their neighbors to attract more patients for increasing profit levels. Positive spillover are observed means technical efficiency of one district hospitals is increasing due to increase in the technical efficiency of the neighbor's district hospital. This finding reveals that at the same time both the district hospitals are attracting more patients (from public sector) to gain profits which shows the increase in the role of private sector hospitals in Pakistan.

To reduce the financial burden, there is need to enhance the performance and quality of public hospitals. Therefore, this study has estimated the technical efficiency score of public hospitals in the second chapter. The findings reveal that the efficiency scores of all the public hospitals are also found to be very low. On the other hand, the relationship between efficiency and quality is significant and positive according to results of this study. Hence, the efficiency enhancement efforts affect the objective quality indicators positively. Technical efficiency is achieving maximum output with given resources and the outcome variable in this chapter is the number of deliveries, while, mortality rate of a hospital is considered as a quality indicator. Increase in efficiency level of a hospital means rise in its volume. Therefore, higher volume is associated with low risk of maternal and neonatal deaths according to literature (LeFevre 1992, Chang, Stamilio et al. 2008). Thus, the increased efficiency of a hospital will further contribute to improving quality of care. Technical efficiency may have indirect effect on patients' level of satisfaction. Furthermore, Patients' perceptions are very important in the measurement of overall quality of a healthcare provider. In the third chapter, the relationship between technical efficiency of healthcare units (DHQs hospitals), and the patients' perceptions about the quality of services is explored. Patients' perceptions towards the healthcare services, is a subjective indicator and it is very similar with satisfaction. It is evident in the literature (Sitzia & Wood, 1997; Williams, 1994) that satisfaction and perceptions are used interchangeably. So, the main variable of the analysis is overall satisfaction. The index of overall satisfaction is formed using four ordinal variables using equal weights, PCA and PPCA for robustness.

The findings of this chapter reveals that negative association exists between efficiency and patients' perceptions which indicates with the increase in hospital efficiency, the satisfaction level of the patients tends to decrease.

This chapter has explored one very interesting result while further exploring the channels through which technical efficiency could affect level of satisfaction. The effect of technical efficiency is observed on the level of satisfaction associated with the attitude of the healthcare provider and with explanation about the illness and treatment as compared to clinical examination and attitude of other staff. This result shows the patients' preferences. When the number of patients increases all the indicators of patients' satisfaction should be affected but the patients' level of satisfaction which they gain from attitude of healthcare provider and explanation about their disease and treatment is affected by the technical efficiency enhancement.

This dissertation contributes to the literature in manifold; it contributes in the literature of competition in hospital market; the application of spatial econometrics in health economics; the causal relation between technical efficiency and quality of a public hospital; the effect of technical efficiency on the satisfaction level of the patients.

The major policy implication, which can be drawn from the findings of chapter one is that, in order to minimize the role of private hospitals in the hospital market, the government should focused on the efficiency and quality of public hospitals. Moreover, it is suggested in the short run, the policy interventions in terms of skill improvement or new technology adaptation could increase the quality of hospitals. This will certainly be spread out to the hospitals of other districts. As the private hospitals are not directly under the control of Government, such policy intervention can reduce the import duties on new technology. This will help in providing short term relief to masses while reducing the burden on their out of pocket health expenditures.

The policy implication which can be drawn from chapter two is that in order to improve the quality of public hospitals, the government and policy makers should be more focused on improving efficiency of these hospitals. The findings of this chapters also support this assertion by suggesting that the risk of maternal and neonatal mortality is relatively higher in less efficient hospitals as compared to the more efficient ones. Given the low resources being allocated for public hospitals in Pakistan along with low efficiency scores of all the hospital, the findings of this study suggests that scarce resources can be managed and utilized in a way to enhance the efficiency level. Thus, the increased efficiency of a hospital will further contribute in improving quality of care in Pakistan.

The last chapter, while studying the trade-off between efficiency and perceived quality, suggests that there should be threshold level for consultation time with the healthcare providers. This is important in order to maintain patient's' satisfaction levels and to avoid inefficiencies as stretched consultations time leads to inefficiencies, affecting the health system. Moreover, short consultation time with the healthcare provider may affect the patients' satisfaction level.

Appendix

Table 2I: Definitions of the Variables

Outputs	
Deliveries	Number of Normal deliveries + C-sections
Inputs	
Specialist	Gynecologist + Anesthetist + Pediatrician
Gynecologist	Medical specialist dealing with the health of the female reproductive systems
Anesthetist	Medical specialist who administers anesthetics
Pediatrician	Medical practitioner specializing in children and their diseases
WMO	Women Medical Officer
Technical staff	OT technician, blood bank technician, lab technician and aesthesia technician
Nurses	Give medical and other attention to a sick person in a hospital
Other staff	LHVs and Ambulance driver

Table 2II: Efficiency scores at district level with provinces and hospital type.

Province	District	Hospital Type	Efficiency Scores	No. Hospitals	Province	District	Hospital Type	Efficiency Scores	No. Hospitals
Punjab	Lahore	1	0.401	2	KPK	Malakand	1	0.833	1
Punjab	Lahore	2	0.289	2	KPK	Malakand	2	0.629	1
Punjab	Lahore	3	0.695	6	KPK	Malakand	3	0.295	4
Punjab	Faisalabad	2	0.393	5	KPK	Malakand	4	0.331	4
Punjab	Faisalabad	3	0.451	11	KPK	Mansehra	1	0.546	1
Punjab	Attock	1	0.613	1	KPK	Mansehra	2	0.499	2
Punjab	Attock	2	0.433	5	KPK	Mansehra	3	0.520	8
Punjab	Attock	3	0.565	5	KPK	Mansehra	4	0.450	8
Punjab	Bahawalnagar	1	0.475	1	KPK	Mardan	1	0.738	1
Punjab	Bahawalnagar	2	0.555	4	KPK	Mardan	3	0.550	6
Punjab	Bahawalnagar	3	0.607	10	KPK	Mardan	4	0.708	2
Punjab	Bahawalpur	2	0.466	4	KPK	Peshawar	3	0.386	3
Punjab	Bahawalpur	3	0.516	9	KPK	Peshawar	4	0.360	2
Punjab	Bhakkar	1	0.615	1	KPK	Peshawar	7	0.718	1
Punjab	Bhakkar	2	0.499	3	KPK	Shangla	1	0.084	1
Punjab	Bhakkar	3	0.548	3	KPK	Shangla	2	0.174	2
Punjab	Chakwal	1	0.683	1	KPK	Shangla	4	0.107	2
Punjab	Chakwal	2	0.616	2	KPK	Swabi	1	0.716	1
Punjab	Chakwal	3	0.605	9	KPK	Swabi	3	0.364	4
Punjab	Chiniot	1	0.323	1	KPK	Swabi	4	0.624	2
Punjab	Chiniot	2	0.504	1	KPK	Swat	2	0.795	1

Punjab	Chiniot	3	0.444	4	KPK	Swat	3	0.529	3
Punjab	D. G.Khan	1	0.658	1	KPK	Swat	4	0.568	6
Punjab	D. G.Khan	2	0.525	1	KPK	Tank	4	0.623	2
Punjab	D. G.Khan	3	0.589	10	KPK	Upper Dir	1	0.656	1
Punjab	D. G.Khan	4	0.771	1	KPK	Upper Dir	2	0.421	3
Punjab	Gujranwala	1	0.404	1	Baluchistan	Awaran	1	0.597	1
Punjab	Gujranwala	2	0.529	3	Baluchistan	Awaran	3	0.492	2
Punjab	Gujranwala	3	0.481	9	Baluchistan	Barkhan	4	0.755	1
Punjab	Hafizabad	1	0.588	1	Baluchistan	Bolan	1	0.535	1
Punjab	Hafizabad	2	0.447	1	Baluchistan	Bolan	3	0.691	3
Punjab	Hafizabad	3	0.564	5	Baluchistan	Bolan	4	0.546	2
Punjab	Jhelum	1	0.712	1	Baluchistan	Dera Bugti	1	0.650	1
Punjab	Jhelum	2	0.562	2	Baluchistan	Dera Bugti	3	0.142	2
Punjab	Jhelum	3	0.687	5	Baluchistan	Gwadar	1	0.537	1
Punjab	Jhang	1	0.406	1	Baluchistan	Gwadar	3	0.353	3
Punjab	Jhang	2	0.562	2	Baluchistan	Harnai	1	0.096	1
Punjab	Jhang	3	0.482	9	Baluchistan	Harnai	3	0.112	1
Punjab	Kasur	1	0.476	1	Baluchistan	Jaffarabad	1	0.281	1
Punjab	Kasur	2	0.694	2	Baluchistan	Jaffarabad	4	0.711	1
Punjab	Kasur	3	0.619	12	Baluchistan	Jhal Magsi	1	0.551	1
Punjab	Khanewal	1	0.505	1	Baluchistan	Jhal Magsi	3	0.335	3
Punjab	Khanewal	2	0.379	3	Baluchistan	Keich	1	0.649	1
Punjab	Khanewal	3	0.466	4	Baluchistan	Keich	3	0.308	11
Punjab	Khushab	1	0.461	1	Baluchistan	Kharan	1	0.449	1
Punjab	Khushab	2	0.284	3	Baluchistan	Kohlu	1	0.693	1
Punjab	Khushab	3	0.506	5	Baluchistan	Kohlu	3	0.097	1
Punjab	Layyah	1	0.636	1	Baluchistan	Khuzdar	1	0.763	1
Punjab	Layyah	2	0.697	3	Baluchistan	Khuzdar	3	0.366	6
Punjab	Layyah	3	0.519	4	Baluchistan	Q Abdullah	1	0.644	1
Punjab	Lodhran	1	0.509	1	Baluchistan	Q Abdullah	3	0.487	3
Punjab	Lodhran	2	0.207	2	Baluchistan	Q Saifullah	1	0.283	1
Punjab	Lodhran	3	0.522	4	Baluchistan	Q Saifullah	3	0.408	2
Punjab	Mianwali	1	0.583	1	Baluchistan	Q Saifullah	4	0.070	1
Punjab	Mianwali	2	0.284	3	Baluchistan	Lasbela	1	0.567	1
Punjab	Mianwali	3	0.477	9	Baluchistan	Lasbela	2	0.734	1
Punjab	Multan	2	0.455	2	Baluchistan	Lasbela	3	0.365	4
Punjab	Multan	3	0.531	7	Baluchistan	Lasbela	4	0.520	1
Punjab	Muzaffargarh	1	0.615	1	Baluchistan	Loralai	1	0.582	1
Punjab	Muzaffargarh	2	0.584	2	Baluchistan	Loralai	3	0.450	2
Punjab	Muzaffargarh	3	0.615	13	Baluchistan	Loralai	4	0.625	1
Punjab	N.Sahib	1	0.563	1	Baluchistan	Mastung	1	0.060	1
Punjab	N.Sahib	3	0.651	9	Baluchistan	Mastung	3	0.332	3
Punjab	Narowal	1	0.606	1	Baluchistan	Musa Khel	1	0.176	1

Punjab	Narowal	2	0.620	1	Baluchistan	Musa Khel	3	0.275	1
Punjab	Narowal	3	0.492	7	Baluchistan	Quetta	3	0.137	3
Punjab	Okara	1	0.450	2	Baluchistan	Sherani	3	0.285	2
Punjab	Okara	2	0.507	2	Baluchistan	Sibi	1	0.158	1
Punjab	Okara	3	0.558	10	Baluchistan	Sibi	3	0.277	3
Punjab	Pakpattan	1	0.576	1	Baluchistan	Washuk	1	0.164	1
Punjab	Pakpattan	2	0.073	1	Baluchistan	Washuk	3	0.165	1
Punjab	Pakpattan	3	0.545	4	Baluchistan	Ziarat	1	0.388	1
Punjab	R.Y. Khan	2	0.506	3	Baluchistan	Ziarat	3	0.625	3
Punjab	R.Y. Khan	3	0.677	19	Baluchistan	Zhob	1	0.633	1
Punjab	Rajanpur	1	0.721	1	Baluchistan	Zhob	3	0.202	4
Punjab	Rajanpur	2	0.016	2	Baluchistan	Pishin	1	0.637	1
Punjab	Rajanpur	3	0.462	6	Baluchistan	Pishin	2	0.637	1
Punjab	Rawalpindi	2	0.668	4	Baluchistan	Pishin	3	0.414	6
Punjab	Rawalpindi	3	0.566	10	Baluchistan	Panjgur	1	0.315	1
Punjab	Sargodha	1	0.412	1	Baluchistan	Panjgur	3	0.102	1
Punjab	Sargodha	2	0.324	4	Baluchistan	Nushki	1	0.682	1
Punjab	Sargodha	3	0.481	14	Baluchistan	Nushki	3	0.533	2
Punjab	Sheikhupura	1	0.467	1	Baluchistan	Naseerabad	1	0.400	1
Punjab	Sheikhupura	2	0.598	1	Baluchistan	Naseerabad	3	0.524	3
Punjab	Sheikhupura	3	0.544	7	Sindh	Hyderabad	2	0.360	6
Punjab	T T Singh	1	0.639	1	Sindh	Hyderabad	3	0.522	3
Punjab	T T Singh	2	0.485	2	Sindh	Karachi	3	0.347	7
Punjab	T T Singh	3	0.480	6	Sindh	Jamshoro	2	0.452	4
Punjab	Vehari	1	0.546	1	Sindh	Jamshoro	3	0.421	5
Punjab	Vehari	2	0.509	2	Sindh	Badin	1	0.687	1
Punjab	Vehari	3	0.410	10	Sindh	Badin	2	0.465	4
KPK	Nowshera	1	0.445	1	Sindh	Badin	3	0.482	11
KPK	Nowshera	3	0.414	7	Sindh	Dadu	1	0.663	1
KPK	Nowshera	4	0.086	2	Sindh	Dadu	2	0.268	3
KPK	Nowshera	5	0.604	1	Sindh	Dadu	3	0.412	3
KPK	Nowshera	6	0.586	1	Sindh	Gokti	1	0.522	1
KPK	Abbottabad	1	0.768	1	Sindh	Gokti	2	0.466	3
KPK	Abbottabad	3	0.447	4	Sindh	Gokti	3	0.377	3
KPK	Abbottabad	4	0.559	5	Sindh	Jacobabad	1	0.646	1
KPK	Bannu	1	0.751	1	Sindh	Jacobabad	2	0.615	1
KPK	Bannu	2	0.148	1	Sindh	Jacobabad	3	0.705	1
KPK	Bannu	3	0.351	2	Sindh	Kashmore	2	0.182	2
KPK	Battagram	1	0.294	1	Sindh	Kashmore	3	0.498	4
KPK	Battagram	3	0.812	2	Sindh	Khairpur	2	0.231	1
KPK	Battagram	4	0.683	1	Sindh	Khairpur	3	0.350	11
KPK	Buner	1	0.627	1	Sindh	Larkana	2	0.245	2
KPK	Buner	3	0.532	3	Sindh	Larkana	3	0.518	5

KPK	Buner	4	0.728	3	Sindh	Matiari	2	0.693	1
KPK	Charsadda	1	0.654	1	Sindh	Matiari	3	0.611	7
KPK	Charsadda	2	0.099	1	Sindh	Mirpur	1	0.562	1
KPK	Charsadda	3	0.263	3	Sindh	Mirpur	2	0.480	2
KPK	Charsadda	4	0.151	1	Sindh	Mirpur	3	0.517	6
KPK	Chitral	1	0.476	1	Sindh	Sukkur	2	0.537	2
KPK	Chitral	2	0.496	3	Sindh	Sukkur	3	0.292	3
KPK	Chitral	3	0.251	4	Sindh	Noshero	1	0.519	1
KPK	D.I. Khan	1	0.460	1	Sindh	Noshero	2	0.517	2
KPK	D.I. Khan	2	0.076	1	Sindh	Noshero	3	0.402	12
KPK	D.I. Khan	3	0.384	4	Sindh	Sanghar	1	0.692	1
KPK	D.I. Khan	4	0.243	3	Sindh	Sanghar	2	0.560	3
KPK	Hangu	1	0.620	1	Sindh	Sanghar	3	0.527	6
KPK	Hangu	3	0.642	2	Sindh	Nawab Shah	2	0.707	1
KPK	Hangu	4	0.702	1	Sindh	Nawab Shah	3	0.590	8
KPK	Haripur	1	0.434	1	Sindh	Shikarpur	1	0.676	1
KPK	Haripur	2	0.509	1	Sindh	Shikarpur	2	0.192	2
KPK	Haripur	3	0.494	6	Sindh	Shikarpur	3	0.400	7
KPK	Haripur	4	0.664	2	Sindh	T.A.Yar	2	0.723	1
KPK	Karak	1	0.231	1	Sindh	T.A.Yar	3	0.269	2
KPK	Karak	2	0.331	2	Sindh	T M.Khan	2	0.542	1
KPK	Karak	3	0.374	4	Sindh	T M.Khan	3	0.277	3
KPK	Karak	4	0.385	4	Sindh	Umer Kot	1	0.758	1
KPK	Kohat	1	0.810	1	Sindh	Umer Kot	2	0.623	3
KPK	Kohat	3	0.620	4	Sindh	Umer Kot	3	0.467	6
KPK	Kohat	4	0.747	1	Sindh	Thatta	1	0.590	1
KPK	Lakki Marwat	1	0.387	1	Sindh	Thatta	2	0.537	4
KPK	Lakki Marwat	3	0.458	5	Sindh	Thatta	3	0.508	8
KPK	Lakki Marwat	4	0.683	3	Sindh	Tharparkar	1	0.641	1
KPK	Lower Dir	1	0.606	1	Sindh	Tharparkar	2	0.513	3
KPK	Lower Dir	2	0.206	2	Sindh	Tharparkar	3	0.412	2
KPK	Lower Dir	3	0.447	5	Sindh	Qamber	2	0.278	4

Table 2III: Relationship between efficiency and death rate with district and province dummies

Variables	Model (1)	Model (2)
Efficiency	-0.106***(0.037)	-0.114*** (0.038)
Gynecologist Residence	-0.011 (0.024)	-0.0122 (0.026)
Anesthetist Residence	0.0066 (0.027)	0.0015 (0.027)
Pediatrician Residence	0.0053 (0.0187)	0.0198 (0.0183)
WMO Residence	0.0108 (0.0108)	0.0282* (0.015)
Ratio Equipment	-0.0298 (0.0033)	-0.036 (0.046)
Ratio Medicines	0.034 (0.026)	0.0451 (0.030)
Ratio WMO	-0.0049 (0.010)	-0.0014 (0.013)
Ratio Specialists	0.0132 (0.0135)	0.0155 (0.014)
Ratio Ambulance	0.0135 (0.0154)	0.0096 (0.017)
Population	0.0054 (0.0051)	0.437 (0.343)
Literacy Rate	-0.0005 (0.0005)	-0.175 (0.132)
HDI	0.0168 (0.092)	0.841 (0.612)
Province		
KPK	0.022 (0.019)	-----
Baluchistan	0.0298 (0.0293)	-----
Sindh	0.010 (0.0184)	-----
District		
Faisalabad	-----	0.273 (0.196)
Attock	-----	1.709 (1.368)
Bahawalnagar	-----	-0.398 (0.294)
Bahawalpur	-----	1.229 (0.9211)
Bhakkar	-----	0.237 (0.2001)
Chakwal	-----	1.025 (0.832)
Chiniot	-----	0.455 (0.404)
Dera Ghazi Khan	-----	-0.689 (0.571)
Gujranwala	-----	1.639 (1.273)
Hafizabad	-----	1.237 (0.9814)
Jhelum	-----	3.959 (3.064)
Jhang	-----	-0.151 (0.093)
Kasur	-----	-1.167 (0.8595)
Khanewal	-----	0.703 (0.557)
Khushab	-----	1.474 (1.173)
Layyah	-----	-2.571(1.89)
Lodhran	-----	-3.029 (2.302)
Mianwali	-----	1.335 (1.055)
Multan	-----	-4.884 (3.695)
Muzaffargarh	-----	-1.063 (0.812)

Nankana Sahib	-----	0.0037 (0.133)
Narowal	-----	2.958 (2.295)
Okara	-----	-1.098 (0.858)
Pakpattan	-----	-3.522 (2.615)
Rahim Yar Khan	-----	-1.765 (1.363)
Rajanpur	-----	-1.722 (1.422)
Rawalpindi	-----	3.128 (2.409)
Sargodha	-----	0.848 (0.64)
Sheikhupura	-----	1.581 (1.25)
Toba Tek Singh	-----	1.674 (1.327)
Vehari	-----	-0.508 (0.363)
Nowshera	-----	0.907 (0.728)
Abbottabad	-----	0.164 (0.206)
Bannu	-----	0.276 (0.261)
Battagram	-----	0.819 (0.642)
Buner	-----	-0.8304 (0.632)
Charsadda	-----	-0.833 (0.586)
Chitral	-----	1.384 (1.12)
Dera Ismail Khan	-----	-1.946 (1.44)
Hangu	-----	0.178 (0.148)
Haripur	-----	2.928 (2.264)
Karak	-----	1.076 (0.862)
Kohat	-----	0.563 (0.431)
Lakki Marwat	-----	-0.335 (0.211)
Lower Dir	-----	0.926 (0.737)
Malakand	-----	1.51 (1.135)
Mansehra	-----	1.409 (1.07)
Mardan	-----	-0.238 (0.377)
Peshawar	-----	-0.379 (0.268)
Shangla	-----	-0.749 (0.513)
Swabi	-----	0.401 (0.32)
Swat	-----	-0.044 (0.136)
Tank	-----	0.741 (0.597)
Upper Dir	-----	1.380 (1.052)
Awaran	-----	0.509 (0.401)
Barkhan	-----	-1.701 (1.283)
Kachhi Bolan	-----	-1.735 (1.306)
Dera Bugti	-----	-3.069 (2.32)
Gwadar	-----	-3.588 (2.66)
Harnai	-----	1.233 (0.983)
Jaffarabad	-----	-0.425 (0.319)

Jhal Magsi	-----	-2.572 (1.93)
Keich	-----	1.108 (0.892)
Kharan	-----	-4.372 (3.39)
Kohlu	-----	-5.251 (3.955)
Khuzdar	-----	0.844 (0.567)
Qila Abdullah	-----	-0.375 (0.298)
Qila Saifullah	-----	-0.570 (0.402)
Lasbela	-----	-3.749 (2.814)
Loralai	-----	-0.801 (0.586)
Mastung	-----	-0.897 (0.825)
Musa Khel	-----	-3.223 (2.379)
Quetta	-----	3.471 (2.502)
Sherani	-----	-4.027 (3.036)
Sibi	-----	0.736 (0.574)
Washuk	-----	-4.072 (3.24)
Ziarat	-----	5.385 (5.39)
Zhob	-----	0.108 (0.200)
Pishin	-----	2.102 (1.61)
Panjgur	-----	-0.411 (0.316)
Nushki	-----	1.055 (0.814)
Naseerabad	-----	-2.92 (2.198)
Hyderabad	-----	3.152 (2.42)
Karachi	-----	-2.212 (1.87)
Jamshoro	-----	-0.235 (0.204)
Badin	-----	-0.651 (0.486)
Dadu	-----	1.931 (1.50)
Gokti	-----	0.349 (0.25)
Jacobabad	-----	-0.470 (0.353)
Kashmore	-----	0.448 (0.371)
Khairpur	-----	1.286 (0.985)
Larkana	-----	0.845 (0.661)
Matiari	-----	0.623 (0.493)
Mirpur Khas	-----	-0.145 (0.146)
Sukkur	-----	1.417 (1.114)
Noshero Feroz	-----	4.02 (3.04)
Sanghar	-----	0.921 (0.716)
Nawab Shah	-----	0.403 (0.336)
Shikarpur	-----	1.495 (1.157)
Tando Allah Yar	-----	1.802 (1.376)
Tando Muhammad Khan	-----	0.489 (0.299)
Umer Kot	-----	1.33 (1.01)
Thatta	-----	-0.794 (0.587)
Tharparkar	-----	-0.636 (0.472)

Constant	0.0492 (0.058)	3.786 (2.93)

Note: Standard errors are given in parenthesis. ***, ** and * show significance at 1%, 5% and 10% levels of significance respectively

Table 2IV Control Variables for evaluation of relationship between quality and efficiency

Gynecologist Residence	Gynecologist residence available or not
Anesthetist Residence	Anesthetist residence available or not
Pediatrician Residence	Pediatrician residence available or not
WMO Residence	WMO residence available or not
Ratio Equipment	Ratio of the required and available equipment and these equipment include OPD , Pediatric ward, Labor room, Operation theatre, Female ward, Clinical lab, Basic lab, Laboratory, Blood transfusion, Radiology service equipment, Family planning commodities and General items.
Ratio Medicines	Ratio of the required and available medicines and these medicines include Supplies, Drugs and Vaccine.
Ratio Specialists	Ratio of the required and available specialists and these specialists include Gynecologist, Anesthetist and Pediatrician.
Ratio WMO	Ratio of the required and available Women Medical Officer
Ratio Ambulance	Ratio of the required and available number of Ambulance service
HDI	Human Development Index
Literacy Rate	Literacy rate is in percentage
Population	Population in 2010/11 in Millions

Table3I: Correlation between Patients' satisfactions related variables

Correlation	Examination	Communication	Provider Attitude	Other staff Attitude
Examination	1			
Communication	0.6493	1		
Provider Attitude	0.5258	0.5475	1	
Other staff Attitude	0.4047	0.4791	0.4989	1

Table 3II: Polychoric Correlation Matrix

Correlation	Examination	Communication	Provider Attitude	Other staff Attitude
Examination	1			
Communication	0.786	1		
Provider Attitude	0.662	0.676	1	
Other staff Attitude	0.548	0.606	0.63	1