Delivery of Health Care Service in the Organization of Islamic Cooperation (OIC) Member States and Regional Diversity: A Bootstrap DEA Analysis

[1]Nabila Asghar, [2]Majid Ali, [3]Fatima Farooq, [4]Urooj Talpur

[1]Assistant Professor Department of Economics and Business Administration University of Education Bank Road campus Lahore, drnabeelakhan.eco@gmail.com
[2]Phd Scholar of Economics NCBA&E Lahore, majid.uos@gmail.com
[3]Assistant Professor, School of Economics, Bahauddin Zakariya University, Multan
[4]Assistant Professor Department of Economics University of Sindh Jamshoro, urooj@usindh.edu.pk

ARTICLE DETAILS	ABSTRACT
History *Revised format: February2019* *Available Online: March 2019* **Keywords** *Health Care System; Efficiency;* *Data Envelopment Analysis;* *Truncated Regression Analysis.* **JEL Classification:** H75, I11, I12, I18	For the last few decades, demographic changes require new and expensive medical innovations, which ultimately put the health care system under financial pressure. Therefore, provision of efficient services for the sustainability in health care system is mandatory. The objective of this study is to explore the performance of health care services provided in 55 OIC member countries during 2011 and 2015.The bootstrap Data Envelopment Analysis and Truncated regression approach have been applied to observe the health system and estimate the efficiency score in 55 OIC member countries. The findings of DEA show that cost efficiency (CE), technical efficiency (TE) and allocative efficiency (AE) of health care system of OIC member countries on average are 0.52, 0.72, and 0.70, respectively. It indicates that OIC countries are not good at selecting cost efficient input mix. The results of truncated regression approach indicate that out-pocket health expenditures is the most important determinant relative to other indicators. It is suggested that it is hard to improve the overall health system at most efficient level. For this purpose there is a need to educate the mass and provide the better opportunities so that people can earn handsome amount, through which they may have better health care.

1. Introduction

Social and demographic changes raise the financial pressure on a common man who suffers from chronic diseases which ultimately put financial pressure on an economy through more expensive and innovative medical system [Schely (2018), Chevreul, et al., (2010)].The increasing demand for new and innovative treatments and an increasing request of quality of life for patients put huge financial burden on an economy (Porter, 2009). Now a days all health related sectors and policy makers are highly concerned with better performance of health system and formulate those policies and introduce reforms which can improve the health care system. Therefore, in order to improve the quantity and quality of health system it is vital to assess this system thoroughly and in depth. (Varela, 2010). How many resources are given for health care and how much is consumed by human can be easily assessed and measured through the efficiencies using bootstrap method. (WHO, 2000). Efficiency means how much an

organization or hospital uses resources to provide the best possible opportunities to the patients over the given period of time (Vitaliano and Toren, 1996).

Farrell initially developed efficiency measures, later applied by Debreu and Koopmans. Mehregan, (2008) defines the economic efficiency as minimizing the cost of producing anything/product. Further, economic efficiency is divided into two parts, one is technical and other is allocative efficiency. The allocative efficiency is the optimally used combinations of the factors of production, whereas the producers stay on the stochastic frontier when behaving as technically efficient (Torkamani, 2009).

There are few studies based on the efficiency, e.g. Pinto (2013) found mean efficiency scores were 0.981 and 0.988 with Constant and variable returns to scale conditions respectively for Italy. De Cos and Moral-Benito (2009) used 29 industrialized countries to find the determinants of health system efficiency using Data Envelopment (DE). The results revealed that Australia attained the highest (0.991) and Hungary the lowest (0.942) efficiency score. Haddad et al., (2013) pointed out that the multiple insurers ultimately leads towards the low efficiency in providing the medical facility. (Hadad, et al. 2013).

Afonso et al.(2005) viewed that those countries having small public sector may achieve the high efficiency score and vice versa in health sector. Ramsay found female literacy and income of the household as the main determinants in health care services (Ramsay, et al., 2001).

Extensive studies conducted to assess the efficacy and efficiency of health systems for different countries, including OECD, European and American countries. A very limited studies have been carried out in developing countries for investigating the factors responsible for low efficiency score of health system.

Therefore, the present study aimed to measure the cost efficiency and finding determinant of efficiency in OIC countries during 2011 to 2015 in health system provided by their respective government.

2. Method and Methodology
Usually cost efficiency is estimated by two methods one is parametric (stochastic frontier (SF)) and other is nonparametric techniques (Data Envelopment Analysis (DEA)). Parametric projection of the stochastic frontier requires a behavioral hypothesis for the minimization of cost. Furthermore, the econometric method is parametric and muddles the effects of misspecification of functional form with inefficiency. DEA technique is nonparametric and owing to trivial conditions put on the form of technology, is less disposed to such kind of error of specification (Parameter, 2014). DEA is built upon relative proficiency procedures suggested by Farrell (1957). In this method a country is considered to be efficient if it is producing on the production boundary. By using the input price attuned operational costs as the input variable of cost efficacy merely estimates Farrell's measure of total efficiency (Linna, et al., 2010). In evaluating the cost efficacy of OIC member countries, the present study uses DEA technique that is based on linear programming method in the estimation of unit-specific efficacy scores (Charness, et al., 1978). DEA makes a piecewise linear efficacy boundary that works as baseline in the assessment of efficiency. If a country is working efficiently it will lie on the production possibility curve and efficacy score of this country will be one which represents 100 percent efficient. Less efficient countries will get a score less than one. For example if score of a country is 0.70 which is measured on the basis of input oriented efficiency, it is seventy percent efficient and thirty percent inefficient which means that 30 percent more output may be produced by using existing resources, alternatively we may say that it is producing only seventy percent of its potentials. If we assume constant returns to scale prevails then the efficiency scores will be similar whether they are obtained by input orientation or output orientation.

Cost efficiency is estimated by solving the following linear program:

$$Min_{\lambda,zCE} \quad Z_{CE}$$

s.t.

$$\lambda.Y \geq y_0$$
$$\lambda.C \leq Z_{CE}$$
$$\lambda_i \geq 0$$
$$\lambda.i = 1$$

Where
Y= It is matrix of dimension n× m of outputs

λ= It is a matrix of dimension 1×n of intensity variables.
C= It is a matrix of dimension n×1 of costs.
CE= it is a scalar demonstrating a country's cost level
i = it is a column vector of 1s.

Allocative and technical efficiency can be solved through system of linear equations, which gives the input-oriented technical efficiency:

$$\text{Min}_{z,u}u$$

Subject

$$z.Y \geq y_o$$
$$z.X \leq x$$
$$z_i \geq 0$$
$$\sum_{i=1}^{n} zi = 1$$

AE is simply calculated by dividing CE to TE, which is as follows:

$$AE = CE/TE$$

At second stage, calculated DEA efficiency score is simply regressed on some other variables to see the effect. There are various techniques to analyze the effect.

Following Asbu(2007), the DEA efficiency scores for VRS may be converted into inefficiency scores using the formula given below:

$$\text{Inefficiency score} = (1/\text{Efficiency Score}) - 1$$

Most commonly, Tobit model is used for DEA anlaysis, but Simar and Wilson (2007) pointed out that such technique are not appropriate. They suggested truncated regression with bootstrap do satisfactory in its performance during Monte Carlo experiments. So, in present study we also apply Bootstrap DEA approach. Simar and Wilson (2007) assumed that distribution is truncated normal with a zero mean (before truncation), unknown variance and a (left) truncation point is determined by this very condition. The general form of the econometric model may be written as:

3. Data Description
The study is conducted to measure cost efficiency of health system of member OIC states for the period of 5 years during 2011 to 2015. The Organization of Islamic Cooperation (OIC) was established in 1969, now have 57 members. The study estimated the efficiency of 55 OIC member countries as data on Palestine is not available.
In this study the following variables are used as a measure of output, and input variables with their corresponding input prices (Table. 1). The selection of these variables is based on early studies (for example,Ogloblin, 2011; Karpa and Leoniowska, 2014; Pourreza, et al., 2017).

Table 1: Brief Description Variables Used

	VARIABLES	**EXPLANATIONS**
Outputs	LE	Average number of years that a person at birth is expected to live
	MMR/100000	Probability of maternal mortality rate per 1000 birth
	IMR/1000	Probability of dying between birth and the first birthday of a child/ 1000 birth
	U5R/1000	Probability of dying between birth and under first five year of a child /1000 birth
Inputs	PHYSIAN /1000	Number of physicians /1000 people
	N&W/1000	Number of nurse and midwives per thousand people
	BEDS/1000	Number of beds in a hospital per thousand people
	COST	Public Health care expenditures in thousands
Environmental		
	OOP	Out of pocket health expenditure % of total health expenditures

LR	Adult Literacy Rate (%)
SW	People using safe drinking water services (% of population)
POPG	Growth Rate of Population%
UR	Unemployment Rate %

In DEA method, data have been compiled from World Health Organization (WHO), United Nations Development Fund, World Bank, and OIC countries' National Health Accounts. Then, the CE of the OIC countries health systems is calculated. The summary statistics of the inputs, outputs and environmental factors are given in Table 2.

Table 2: Descriptive Statistics of Inputs and Outputs

		Output				Inputs			
		LE	IMR	MMR	U5MR	Phy	N&W*	BEDS*	COST
2011	**MEAN**	67.88	39.32	309.98	56.26	1.06	1.68	1.56	49.87
	MEDIAN	70.46	35	157	43.7	0.64	0.94	1.08	48.44
	S.D	9.02	25.68	335.94	42.2	1.12	1.62	1.38	18.85
	MAX	80.63	97.3	1580	149.8	3.92	6.01	7.7	92.02
	MIN	49.64	6.8	4	8	0.02	0.04	0.27	19.19
2012	**MEAN**	68.21	38.07	301.45	54.11	1.34	1.98	2.14	49.72
	MEDIAN	70.65	33.2	155	41.1	1.09	1.23	1.9	48.17
	S.D	8.88	24.92	325.65	40.61	1.18	1.73	1.5	19.72
	MAX	80.82	93.1	1510	145.2	3.84	7.86	7.6	91.82
	MIN	50.34	6.8	4	7.9	0.04	0.07	0.4	2.03
2013	**MEAN**	68.53	36.88	293.55	52.11	1.29	2.08	2.64	49.9
	MEDIAN	70.84	31.4	162	38.6	0.98	1.64	2.4	49.62
	S.D	8.74	24.2	317.31	39.13	1.14	1.9	1.5	20.02
	MAX	80.99	89.4	1460	140.7	3.75	8.87	8.1	92.15
	MIN	50.96	6.7	4	7.8	0.03	0.17	0.9	14.63
2014	**MEAN**	68.84	35.77	286	50.22	1.29	2.11	1.89	50.55
	MEDIAN	71.01	29.7	158	36.3	1.28	1.05	1.59	51.7
	S.D	8.63	23.56	309.16	37.77	1.04	1.97	1.57	20.22
	MAX	81.14	86.2	1410	136.7	3.49	8.37	7.7	93.86
	MIN	51.51	6.6	4	7.7	0.03	0.19	0.23	16.99
2015	**MEAN**	69.15	34.72	278.13	48.47	1.37	2.33	1.68	49.84
	MEDIAN	71.18	28.2	155	34.2	1.38	1.05	1.47	47.39
	S.D	8.53	22.94	300.19	36.5	1.09	2.42	1.37	18.87
	MAX	81.29	83.3	1360	132.5	3.87	11.65	7.7	91.82
	MIN	51.99	6.5	4	7.6	0.04	0.08	0.18	17.63

Source: Authors' Calculation

4. Efficiency Result

We have computed all three efficiencies using bootstrap DEA for VRS for 55 OIC member states and results are presented in Table 3. The table shows technical efficiency (TE) in the second column, allocative efficiency (AE) in the third column followed by cost efficiency (CE) in the last column. It indicates that TE, AE and CE on average are 0.70, 0.72, and 0.51, respectively during the study period. Results indicate that more than seventy percent of the countries are allocatively and technically efficient, but only about 50 percent are cost efficient which shows that they are not good for selecting the input combinations which minimizes the cost optimally.

Further, if we see cost efficiency in depth, as the average of the 55 OIC member countries shows 0.51, there is 49% showing inefficiencies during the same period. It indicates that there is a possibility to improve its overall effect by removing the 49% inputs at current output level. Out of 55 countries only 7 (13%) countries fully achieve the overall cost minimization i.e. Afghanistan, Albania, Chad, Lebanon, Pakistan, Sierra Leone and Somalia. While 48 (87%) countries are found away from the optimal cost obtained from the existing technology. Further, 6 countries (11%) fall in the range of CE scores 0.70 to 0.99 and 32 (58%) countries are using more than 50% cost increasing resources in their healthcare system. Most expensive healthcare systems are found in Yemen, Kuwait, Togo,

Kazakhstan, Azerbaijan and Burkina Faso as compare to other member countries where more than 80% resources are increasing the cost of their health care system. These countries can reduced 80% of their healthcare resources at given output level.

Afghanistan, Albania, Chad, Lebanon, Pakistan, Sierra Leone and Somalia, are allocatively fully efficient, whereas the allocative efficiency for an individual country is 0.72, which could be further decreased inefficiency from 18% by reallocating the input combinations. Although cost efficiency for Yemen, Kuwait, Togo, Kazakhstan, Azerbaijan and Burkina Faso are quite low, even lower than 0.20, but their AE score are quite better.

It is evident from the findings that these countries are good enough in allocating the resources and inputs while not expert in getting the input combinations ideally which minimizes the cost at the optimal levels. It also shows that only two countries Burkina Faso and Yemen, have more than 80% misallocation of resources at the given prices.

While assessing the technical efficiency, Afghanistan, Albania, Chad, Comoros, Gambi, Lebanon, Mauritania, Pakistan, Sierra Leone and Somalia show the maximum efficiency (1.00), and Benin, Niger, Brunei, Morocco, Guinea, Tajikistan, Indonesia and Mali are following with TE in the range 0.90-0.99. It meansthat there is no unnecessary input-mix in the health system of OIC member countries for a given level of output with the current technology. Out of 55, 43 (78%) countries indicate the comparatively high level of the technical efficiency while only 7 countries i.e. Saudi Arabia, Kuwait, Togo, Uzbekistan, Kyrgyz, Azerbaijan, Kazakhstan are technical inefficient, which may be viewed as it could be further declined whether by changing the combinations of the inputs or by downing the input scale.

Overall, the cost efficiency over the 55 OIC member countries represents very low as compared to the allocative and technical efficiency during the study period. It indicates that these member countries are good at allocating the input-mix and using appropriate input-mix, but may be not good at selecting optimal cost obtained from the existing technology.

Table 3: Technical, Allocative and Cost Efficiency Scores of the OIC Countries (2011-15)

COUNTRIES	TECHNICAL EFFICIENCY	ALLOCATIVE EFFICIENCY	COST EFFICIENCY
OIC	2011-15	2011-15	2011-15
Afghanistan	1	1	1
Albania	1	1	1
Algeria	0.57	0.76	0.42
Azerbaijan	0.29	0.69	0.16
Bahrain	0.6	0.51	0.31
Bangladesh	0.57	0.76	0.43
Benin	0.98	0.93	0.91
Brunei.	0.96	0.67	0.63
Burkina Faso	0.47	0.3	0.14
Cameroon	0.77	0.57	0.39
Chad	1	1	1
Comoros	1	0.68	0.68
Cote d'Ivoire	0.46	0.76	0.35
Djibouti	0.84	0.69	0.56
Egypt	0.5	0.57	0.28
Gabon	0.52	0.74	0.34
Gambi	1	0.93	0.93
Guinea	0.94	0.68	0.64

Guinea-Bissau	0.8	0.75	0.6
Guyana	0.69	0.82	0.59
Indonesia	0.92	0.75	0.7
Iran,	0.88	0.71	0.61
Iraq	0.54	0.89	0.47
Jordan	0.51	0.59	0.3
Kazakhstan	0.23	0.71	0.16
Kuwait	0.36	0.51	0.17
Kyrgyz	0.31	0.83	0.25
Lebanon	1	1	1
Malaysia	0.66	0.57	0.36
Maldives	0.49	0.66	0.29
Mali	0.91	0.58	0.54
Mauritania	1	0.98	0.98
Morocco	0.95	0.99	0.94
Mozambique	0.55	0.72	0.39
Niger	0.97	0.72	0.7
Nigeria	0.44	0.62	0.25
Oman	0.66	0.58	0.35
Pakistan	1	1	1
Qatar	0.81	0.43	0.35
Saudi Arabia	0.37	0.63	0.23
Senegal	0.73	0.48	0.34
Sierra Leone	1	1	1
Somalia	1	1	1
South Sudan	0.69	0.5	0.3
Suriname	0.48	0.81	0.39
Syrian	0.66	0.71	0.47
Tajikistan	0.93	0.8	0.76
Togo	0.32	0.71	0.17
Tunisia	0.64	0.81	0.52
Turkey	0.54	0.69	0.36
Turkmenistan	0.6	0.69	0.41
Uganda	0.62	0.45	0.23
UAE	0.73	0.58	0.41
Uzbekistan	0.32	0.81	0.24
Yemen, Rep.	0.59	0.29	0.17
	SUMMARY STATISTICS OF EFFICIENCIES SCORE		
	2011-15	2011-15	2011-15
AVERAGE	0.7	0.72	0.51

MEDIAN	0.69	0.73	0.42
S.D	0.28	0.22	0.3
MAXIMUM	1	1	1
MINIMUM	0.15	0.2	0.11

4.1   Bootstrap Truncated Regression

At the second stage, determinants of efficiency are estimated by using regression analysis in the light of technique suggested by Simar and Wilson (2007). The results are presented in Table 4.

Table 4: Truncated Regression Analysis

	TECHNICAL INEFFICIENCY	**ALLOCATIVE INEFFICIENCY**	**COST INEFFICIENCY**
OOPHE	0.3521*	0.207**	0.2615*
LR	-0.0621*	-0.0183*	-0.0429*
SW	-0.0381**	-0.02513*	-0.0248*
Pop Growth	0.0251*	0.1024**	0.0410***
UR	0.0024*	0.0049***	0.0029**
C	1.2031*	1.1304**	2.1801*
***, **, and * represent significance at 1, 5, and 10 percent points.			

Note: Estimation based on Algorithm 1 with 2000 bootstrap followed by Simar and Wilson, (2007).

The regression results shown in Table 4 have been obtained after 1000 iterations, the dependent variable is inefficiency scores and the independent variables are out of pocket health expenditure percentage of total health expenditure, literacy rate, and percentage of population access safe drinking water, population growth rate and unemployment rate. The first independent variable OOPHE which has positive coefficient and variable is statistically significant. It indicates that as there is an increase in share of OOP in total health expenditure, there will be an increase in technical, allocative and cost inefficiency. However the increase in technical inefficiency is greater than allocative and cost efficiency. This positive impact of first independent variable may be due to the reason that a unit increase in OOPTHE leads to an increase in private health expenditures as compare to public health expenditures. OOP negative effects of out-of-pocket payments on access to and equity of health services (Kirgia, etal., 2015). People may prefer to use private health facilities and public health facilities will face inefficiency due to improper facilities of public health system, which ultimately enhance the inefficiency of the health care system. The next variable is literacy rate which has negative but statistically significant. It indicates that as there is an increase in education level, there will be a decrease in efficiency (TE, AE, CE) which may be due to the reason that an increase in education level leads to an increase in awareness regarding the diseases and relevant preventive measures. Probability of getting sick will be less with better education of the People. The coefficient of percentage of population having access to safe water showing significant effect, which explains that maximum people have safe drinking water, would not get sick. The next variable is population growth rate is positive and significant which indicates that size of the population increases the inefficiency of the health care system as population grows there is be less facilities to the greater mob as resources will be divided and less facilities will in return available per person. The coefficient of unemployment is positive and statistically significant which indicates that inefficiency of the health care system increases along with an increase in unemployment.

5. Conclusion and Recommendations

The health systems of the OIC member countries have been examined using Boots strap DEA. The empirical findings reveal that 50% of the efficiency score is obtained, which can be further improved through re-allocation of resources at the best efficient way in health system. In this milieu, this study has contributed by giving policy makers useful information about the economic performance of selected OIC countries particularly about the regional health system. It is pointed out that there is presence of potentials to improve the technical efficiency through optimal use of input combinations. Out of pocket health expenditures and literacy rate have more impact on technical, allocative and cost efficiency as compare to other factors. The government of these countries should prioritize and allocate more resources to finance health as well as in education sectors as compare to other sectors of the economy.

References

Afonso A, SchuknechtL,andTanzi V (2005). "Public sector efficiency: an international comparison". Public Choice 2005; 123: 321–47.

BankauskaiteV,andDargent G (2007). "Health systems performance indicators: methodological issues". Presupuesto y GastoPúblico2007; 49: 125–37.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. European journal of operational research, 2(6), 429-444.

Chevreul K, Durand-Zaleski I, Bahrami S, Hernández-Quevedo C, Mladovsky P. (2010) France: Health system review. Health System Trans. 12(6):1:291

Clayton AC (2010). "Assessing the Productive Efficiency of US Health Care: Comparison of Analytical Methods" .Honors Projects 2010: 106.

Collins C and Green A. (1994) "Decentralization and primary health care: some negative implications in developing countries". IntJ Health Serv1994; 24: 459–76.

de Cos PH and Moral-Benito E.(2013)"Determinants of health-system efficiency: evidence from OECD countries:. Int J Health Care Finance Econ 2014: 14; 69–93.

Farrell, M. J. (1957). The measurement of productive efficiency. Journal of the Royal Statistical Society. Series A (General), 120(3), 253-290.

Hadad S, HadadY,and Simon-Tuval T. (2013) "Determinants of healthcare system's efficiency in OECD countries". Eur J Health Econ 14: 253–65.

Linna, M., Häkkinen, U., Peltola, M., Magnussen, J., Anthun, K. S., Kittelsen, S., &Rehnberg, C. (2010). Measuring cost efficiency in the Nordic Hospitals—a cross-sectional comparison of public hospitals in 2002. Health care management science, 13(4), 346-357.

Mehregan MR.(2008)"Quantitative models for assessment of organizations performance (DEA). Tehran: School of Management, Tehran University; 2008.

Parmeter, C. F., &Kumbhakar, S. C. (2014). Efficiency analysis: a primer on recent advances. Foundations and Trends® in Econometrics, 7(3–4), 191-385.

Parkin D, McGuire A, Yule B. (1987) Aggregate health care expenditures and national income. J Health Econ.6(2):109–27. doi: 10.1016/0167-6296(87)90002-6.

Pinto C (2013). "TE in the Production of Aggregate Regional Health Outcomes in Italy:.Finance Research 2013; 2: 4–11.

Ramsay CR, Grant A, Wallace S, GarthwaiteP,and Monk A, Russell I (2001). "Statistical assessment of the learning curves of health technologies"HealthTechnol Assess 2001; 5: 1–79.

Schieber G.J. (1995)"Preconditions for health reform: experiences from the OECD countries". Health Policy 1995; 32: 279–93.

Schley K. (2018). Health care service provision in Europe and regional diversity: a stochastic metafrontier approach. Health economics review, 8(1), 11. doi:10.1186/s13561-018-0195-5

Torkamani J. (2009) "The impact of insurance on farmers' TE and risk aversion: the use of stochastic frontier production functions". Journal of Agricultural and Development Economics 2009; 22: 45–8.

Varela PS, de Andrade Martins G,andFávero LPL (2010). "Production efficiency and financing of public health: an analysis of small municipalities in the state of São Paulo—Brazil". Health Care ManagSci2010; 13: 112–23.

Vitaliano DF, Toren M. (1996)"Hospital cost and efficiency in a regime of stringent regulation "East Econ J 1996: 22; 161–75.

Wooldridge J. (2002) Econometric Analysis of Cross Section and Panel Data. Cambridge: MIT Press; 2002.

World Health Organization (WHO) (2000). "The world health report 2000 - health systems: improving performance: Geneva: WHO; 2000.