International Review of Business Research Papers
Vol. 3 No.4 October 2007 Pp.111-124

Total Performance of the Health Systems: A Comparative Study of Arab and African Countries

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This present work aims to evaluate the health effectiveness in various Arab and African countries by referring to the efficiency of their health care system. The adopted approach consists in determining efficiency as regards the capacity of the system to transform its medical "inputs" into health "outputs". This is carried out by using a nonparametric approach called DEA method (Data Envelopment Analysis). We used the two approaches of DEA method, the input oriented approach to measure the efficiency of the systems of health and the output oriented one to judge their effectiveness. This makes a point of answering the following questions: What has been done so far about efficiency of the health system in the Arab and African countries? Can efficiency guarantee the effectiveness of the health system? And what are the factors likely to influence it?

Field of Research: Health Economic, Efficiency, Effectiveness.

1. Introduction

The improvement of the effectiveness of the health care system is the main objective of the authorities in their actions to stop the rise of the health expenditure (Evans et al., 2000). This willingness to reduce the costs in the medical field requires the assessment of the performance of systems of care, in the one hand, and their output in the other hand. The health systems play a crucial role in determining the results of health. However, we intend to find an explanation for the differences of the care systems (Murray et al., 1994) of African and Arab countries (37 countries: 18 Arab and 19 African countries). They can be examined according to two categories of objectives: efficiency and effectiveness.

The technical effectiveness can be compared to the internal effectiveness of the health sector that is the relations between the medical resources implemented on the one hand and the outcomes of health obtained on the other hand. Technical efficiency is the possibility of producing a maximum quantity starting from a specific input (Evans et al.; 2000). It is measured out of the relation between the production observed and the maximum production following the use of the input. The study relating to the performance of the health systems requires a specification of the efficiency and effectiveness objectives (Murray et al. 1999). In this analysis, the product of the care system is that of the improvement of the health as discussed by Berki (1972).

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In the empirical part (4), we will present the comparative study of the various health systems (Arab and African) that will be dealt with in the second section (4.2) which is composed of three main parts: firstly we will present the choice of the inputs and the outputs, secondly, the choice of the analysis method of the health systems and thirdly the main results that include the evaluation of the efficiency (Input-Oriented DEA) and the effectiveness (Output-Oriented DEA) and in the third section (4.3) we will examine the factors likely to influence the efficiency of these systems.

2. Literature Review: Performances in Health and Technical Effectiveness

The evaluation of the performance of a productive entity, relating to the health system, requires the definition and the measurement of its activity. The question of the definition and the measurement of the product in terms of health is a complex issue that triggers controversial debates. In the health sector, the difficulty of the specification of the function of production is mainly due to the choice of outputs and not to that of inputs (Bosmans & Fecher 1992). At one extreme, some authors believe in the total non-determination of the medical product which they identify with the improvement of the health of a patient or a population. At the other extreme, the problem of the production of the health system is shrugged off by taking into account indicators of volumes of production (number of entries or days, number of acts…) Sicotte et al. (1996). To measure the effects of a medical action thus amounts to measuring a variation of health before and after the intervention by neutralizing all the other possible causes and effects. The measurement of the health product is calculated as the difference between two health conditions before and after the treatment (Hornbrook, 1982).
Two DEA approaches of efficiency measurement are considered; an input-oriented approach defined as the possibility of producing starting from a minimal quantity of input in order to produce a specific quantity of output and the output-oriented approach, defined as the possibility of producing the maximum of output starting from a specific input (Evans & al. 2000, Murray & al. 1999, Coelli 1996). These two approaches give the same result under the assumption of the constant returns to scale because they identify the same category of producers efficients/inefficients or of decision-making units (DMUs: Decision Making Unities).

To take account of the criterion of maximality of the product obtained on the one hand, and to accept the possibility of under use of the resources on the other hand, one often resorts to the concept of frontier to the detriment of the function of production (Leleu & Dervaux1997). For Perelman (1996), the frontier is a kind of envelope, which often coincides with all points, recognized as representative of the best practice in the field of production, and to which, the performance of each company could be compared.

The methodology of the borders (frontier) allows the identification, the measurement and the analysis of the technical or productive effectiveness synonymous with efficiency. Efficiency breaks up into three types of economic effectiveness (technical effectiveness (Debreu 1951, Koopmans 1951 and Farrell 1957), allocative effectiveness and scale effectiveness) which can be observed at the level of the company (Chaffai, 1989).

In another respect, global performances depend primarily on general level of progress of each country in relation to a certain number of objectives and on the distribution of this level within the population (Robine et al., 1987).

3. Methodology and Research Design

3. 1. The DEA Method: Definition

In this study, we favour the nonparametric approach in research known as Data Envelopment Analysis: DEA method (Seiford & Thrall, 1990 and Ali & Seiford, 1993). It is a method founded on the microeconomic theory, which compares all the similar units in a given population, by taking into account simultaneously several dimensions. It determines the border of efficiency from the point of view of the best practice and provides composite evaluations (Seiford, 1999).

Indeed, the major characteristic of these methods is the fact of not imposing a particular specification of the function of production (these methods make it possible to consider at the same time several outputs and several inputs). To assess efficiency we will consider input-oriented DEA model. In the case of effectiveness we will apply the output-oriented model.

3. 2. The DEA Framework

An intuitive way to proceed, is to introduce DEA method in the form of ratio between all the outputs and all the inputs of each unit of decision (country for our case), i.e. as $u' y_i / v' x_i$.
The problem consists for each unit of decision in determining optimal weightings by solving the following mathematical program:

$$\begin{cases} \max_{u,v} (u' y_i / v' x_i) \\ sc \\ v' x_i = 1 \\ u' y_j - v' x_j \leq 1 \\ u, v \geq 0 \end{cases} \qquad (A)$$

Where, u and v were replaced by λ and θ to indicate that it is a different linear program. By using the duality in linear programming, we obtain the equivalent of the program (A) in the shape of an envelope:

$$\begin{cases} \min_{\theta, \lambda} \theta \\ sc \\ - y_i + Y \lambda \geq 0 \\ \theta x_i - X \lambda \geq 0 \\ \lambda \geq 0 \end{cases} \qquad (B)$$

If θ =1, the observed unit of decision is located on the border, it is therefore effective with reference to Farrell. On the contrary if θ < 0, that reveals the existence of a technical inefficiency.

4. The DEA Method Applied to the Health Systems

4. 1. Adopted Approach

The efficiency scores are calculated with the input-oriented approach (Variable Returns to Scale: VRS). In other words, how much it is necessary to decrease the health sector's input while keeping the same level of profitability of these inputs (efficiency determination). Secondly, we will adopt the output-oriented approach (VRS) to evaluate the health system effectiveness. This will enable us to determine the quantity of output which we can reach for a specific amount of input.

Our analysis is founded on a complex indicator: the technical effectiveness (efficiency). This concept is related to the function of production which is defined as being the technical relation which makes it possible to obtain the maximum output for a combination of production factors and a given technology. It is in a way, the capacity of the system, to transform its medical "inputs" into health "output" (Bosmans & Fecher, 1992). A given health system will be considered effective, when its combination of outputs and inputs is located on the border. "The degree of effectiveness then measures the importance of the variation compared to the border. It is regarded as an indicator of the productive performance" (Tulkens, 1986).

4. 2. Compared Efficiency of the Health System of Arab and African countries

Data are extracted from the site of the World Health Organization and the World Bank. They cover the period 1998-2005, and relate to 37 countries (19 Arab countries and 18 African countries chosen according to the availability of the data). In the applications of DEA method in the field of health, the analysis is generally at the microeconomic level (hospital).

4. 2. 1. Choice of the Inputs and the Outputs

For each country, we consider the hospitals as the only production unit considered here as the DMU (Chilingirian, 1994). We chose as outputs: the life expectancy at birth, the life expectancy in good health and the under five years death rate. For the inputs, we usually distinguish the labour factor from the capital. Labour is measured by the number of physicians per 1000 inhabitants. The capital is represented by the number of beds per 1000 inhabitants and the total expenditure of health in % of GDP.

4. 2. 2. Choice of the Analysis Method of the Health Systems

Our analysis is based on the model with the hypothesis of the VRS in the input-oriented model to measure efficiency and the output-oriented model for efficiency measurement. The choose of the VRS is justified by the fact that, it is a general approach and by taking into account the multi-factors feature in the Health sector.
The scores of efficiency are estimated by the software Data Envelopment Analysis Program (DEAP). They lie between zero and one. The more they approach the unit, the more the country is considered as efficient.

4. 2. 3. Results

- Analysis of Efficiency Scores: Input-Oriented Model

We choose three combinations of inputs and outputs (3 DEA models) that are distributed as follows:

Table1: DEA Models

	Inputs	Outputs
DEA1	- Expenditure of health in % of GDP.	- Life expectancy in good health.
DEA2	- Number of physicians/1000 inhabits. - Number of beds of hospital/1000 inhabits.	- Life expectancy at birth. - Under five mortality rate.
DEA3	- Number of physicians/1000 inhabits. - Expenditure of health per capita.	- Life expectancy at birth - Under five mortality rate

Efficiency scores are presented in the table 2 as follows:

Table 2 : Efficiency Scores

Countries	DEA1 Model		DEA2 Model		DEA3 Model	
	Eff Score	**Range**	**Eff Score**	**Range**	**Eff Score**	**Range**
Algeria	0.992	8	0.217	27	0.709	29
A. Saudi	0.992	8	0.236	24	0.813	24
Bahrain	0.998	2	0.081	37	0.668	32
Djibouti	0.887	26	0.614	14	0.864	18
Egypte	0.988	14	0.117	33	0.558	35
EAU	0.998	2	0.102	35	0.848	20
Iraq	0.968	16	0.461	15	0.861	19
J. Libya	0.997	5	0.091	36	0.756	27
Jordan	0.992	8	0.236	24	0.662	33
Kuwait	0.794	31	0.106	34	0.801	26
Lebanon	0.991	13	0.242	23	0.802	25
Morocco	0.991	13	0.236	24	0.516	37
Mauritania	0.922	23	0.346	22	0.927	14
Oman	0.998	2	0.126	31	0.843	21
Qatar	1.000	1	0.122	32	1.000	1
R. Syria	0.994	7	0.194	28	0.717	28
Soudan	0.964	20	0.362	21	0.820	23
Tunisia	0.995	6	0.194	28	0.684	31
Yemen	0.966	18	0.375	17	0.692	30
Angola	0.691	37	0.375	17	1.000	1
Benin	0.908	25	0.920	9	1.000	1
Burkina Faso	0.736	34	0.762	11	0.999	8
Cameron	0.858	28	0.941	8	0.555	36
Cap-Verde	0.992	8	0.137	30	1.000	1
Congo	0.957	22	0.634	13	0.993	13
Cote d'Ivoire	0.817	30	0.982	4	0.873	17
Gabon	0.972	15	0.374	19	0.595	34
Gambia	0.966	18	0.390	16	0.834	22
Ghana	0.967	17	0.369	20	0.997	10
Kenya	0.920	24	0.943	7	1.000	1
Malawi	0.722	36	1.000	1	0.894	15
Mali	0.781	32	0.822	10	0.976	12
Mozambique	0.763	33	0.976	5	1.000	1
Niger	0.734	35	1.000	1	1.000	1
Nigeria	0.860	27	0.967	6	0.997	10
R. Tanzania	0.835	29	1.000	1	1.000	1
Senegal	0.962	21	0.638	12	0.879	16
Average of Arab countries	**0.969**	**-**	**0.235**	**-**	**0.765**	**-**
Average of African countries	**0.857**	**-**	**0.735**	**-**	**0.922**	**-**
Total average	**0.915**	**-**	**0.478**	**-**	**0.841**	**-**

We note that in the two models with two inputs (DEA2, DEA3) the technical effectiveness (efficiency) is around 66 % (48% and 84%), it is higher in the model with only one input (91.5%).

In the first model (DEA1), 1 country (Qatar) has an efficient system of health; 3 countries in DEA2 (Malawi, Niger, and Tanzania) and 8 countries in DEA3 (Qatar, Angola, Benin, Cap Verde, Kenya, Mozambique, Niger and Tanzania). These countries reported with efficient health system constitute the border to which the other countries are measured.
It is noted, however, that only three countries have efficient systems of health for two models DEA: Qatar (DEA1, DEA3), Niger (DEA2, DEA3) and Tanzania (DEA2, DEA3).
The efficiency scores for the Arab countries for the three models are respectively 0.969; 0.235 and 0.765 (the average is 0.709) and for the African countries are 0.857; 0.735 and 0.922 (the average is 0.838).

By comparing the mean of the three models we notice that the Arab countries appear less efficient than the African countries. Although the average of GDP per capita per day in the Arab countries is 9.24 (in international $) whereas that of the African countries is 1.64, that is to say 5.63 times higher. This result leads us to wonder about the causes of the efficiency of the African countries.

We notice here that the poorest countries are the most efficient ones, at the same time they have the weakest results of life expectancy (at birth or in good health) and of high infant mortality rates compared to the other countries.
This remark enables us to conclude that an efficient system is not necessarily effective. The result entails an evaluation of the health system effectiveness.

- Analysis of Effectiveness Scores: Output-Oriented Model (DEA1)

In this part we will apply the DEA1 oriented on the output in order to determine effectiveness of the health systems of the countries of this sample.
The choose of DEA1 is due to its higher efficiency score in the one hand and that it is easier to interpret because of its composition by one input and one output.
Arab countries are most efficient in DEA1 model (input-oriented) with a score of 0.969. Africans countries have a score of 0.857.

Table 3: Life Expectancy in Good Health Predicted by the Output-Oriented Model (DEA1)

Countries	LEGH	PLEGH	Difference	LEGH/PLEGH	Efficiency Scores
Algeria	61	62,821	1,821	0,971	0.678
A. Saudi	61	65,435	4,435	0,932	0.695
Bahrain	64,3	66,533	2,233	0,966	0.678
Djibouti	42,9	61,871	18,971	0,693	0.487
Egypte	59	60,2	1,2	0,980	0.479
EAU	63,9	67,2	3,3	0,951	0.836
Iraq	50,2	53,568	3,368	0,937	1.000
J. Libya	63,7	63,7	0	1	0.678
Jordan	61	63,035	2,035	0,968	0.296
Kuwait	67,2	67,2	0	1	0.794
Lebanon	60,4	64,316	3,916	0,939	0.272
Morocco	60,2	60,2	0	1	0.545
Mauritania	44,6	54,121	9,521	0,824	0.662
Oman	64	64,962	0,962	0,985	0.859
Qatar	65,3	67,2	1,9	0,972	1.000
R. Syria	61,8	61,8	0	1	0.545
Soudan	48,6	51,911	3,311	0,936	0.646
Tunisia	62,5	62,631	0,131	0,998	0.515
Yemen	49,4	54,121	4,721	0,913	0.505
Angola	33,4	59,095	25,695	0,565	0.968
Benin	43,9	51,911	8,011	0,846	0.631
Burkina Faso	35,6	51,911	16,311	0,686	0.496
Cameron	41,5	53,016	11,516	0,783	0.662
Cap-Verde	60,9	62,489	1,589	0,975	0.604
Congo	46,3	53,568	7,268	0,864	0.957
Cote d'Ivoire	39,5	51,358	11,858	0,769	0.772
Gabon	51,5	63,926	12,426	0,806	0.631
Gambia	49,5	51,358	1,858	0,964	0.343
Ghana	49,7	49,7	0	1	0.617
Kenya	44,5	51,358	6,858	0,866	0.646
Malawi	34,9	49,7	14,8	0,702	0.299
Mali	37,8	51,911	14,111	0,728	0.579
Mozambique	36,9	50,805	13,905	0,726	0.591
Niger	35,5	49,7	14,2	0,714	0.591
Nigeria	41,6	50,253	8,653	0,828	0.556
R. Tanzania	40,4	50,805	10,405	0,795	0.646
Senegal	48	53,568	5,568	0,896	0.545
Total Average	**50,876**	**57,547**	**6,672**	**0.884**	**0,630**
Average Arab countries	**58,474**	**61,728**	**3,254**	**0.947**	**0,640**
Average African countries	**42,855**	**53,135**	**10,280**	**0.806**	**0,619**

LEGH: Life Expectancy in Good Health.
PLEGH: Predicted Life Expectancy in Good Health.

As shown in table 3, we notice that with a constant amount of health expenditure in % of GDP (input), these countries are able to ensure an increase of the average of the life expectancy in good health (effectiveness) of 6.67 years distributed as follows: 3.25 years for the Arab countries and 10.28 years for the African countries. The African countries are shown less powerful as regards production of life expectancy (in projection

in output model). Indeed, these countries have the possibility of producing 10.28 additional years with the same input while the Arab countries had only 3.25 years. Five countries produce a life expectancy equal to the projected level by keeping constant their amount of input. These effective countries are Libya, Kuwait, Morocco, Syria and Ghana.

The African countries are less effective than the Arab countries and are able to produce only to 80.6% of the years of life in good health compared to what they can carry out with the same amount of input. The Arab countries produce a life expectancy in good health to 94.6%. In DEA1 Model, Arab countries are effective and efficient in the same time.

Thus the efficiency of a system does not imply necessarily its effectiveness. It is not only measured by the cost of the years that a system can produce but also in terms of transformation of its inputs into expected outputs.

We can conclude that the African countries are more efficient economically (exploitation of their resources) but ineffective medically as regards improvement of health and increase of life expectancy (that it is with the birth or in good health).

4. 3 Factors likely to influence technical efficiency

In following section, we will establish a relation between the level of efficiency and certain structural variables (the question raised about the origin of the efficiency of the African countries). The study relating to the factors influencing the effectiveness requires a more significant handling with regard to epidemiological and medical variables in order to explain the effectiveness as an improvement of the health status. We generally proceed in two steps: first, we will retain the scores of efficiency carried out by DEA method; second, we will explain these scores by using Ordinary Least Squares regression OLS (Greene, 2003).

A review of literature enables us to distinguish four main categories of factors affecting inefficiency (Brun & Mathonnat, 1997, Duret, 1999; Flegg, 1982, 1983):
- Economic variables: one can retain the extent of the poverty and the inequalities of incomes. Our choice is based on the index of human poverty (IHP).
- Socio-sanitary variables: as indicator we rely on the percentage of the population having access to a source of healthy water.
- Education variables: the rate of adults literacy is used as a variable that characterizes education.
- Demographic variables: in the selection of the demographic variables, our choice rests on the variable of the rate of urbanization (the relation awaited between this variable and the inefficiency is not identifiable).

The OLS regression estimated (considering the data available), is as follows:

$Y_i = \ln (1/z_i) = \alpha_0 + \alpha_1 x_{1i} + \alpha_2 x_{2i} + \alpha_3 x_{3i} + \alpha_4 x_{4i} + \varepsilon_i$

z_i = Technical Effectiveness;

x_{1i} =IHP = human poverty indicator;

x_{2i} =Population with no access to water amenities (in %);
x_{3i} =literacy adults Rate;
x_{4i} =Rate of urbanisation.

Table 4: Regression of Factors Likely to Influence the Efficiency (OLS)

	DEA1	DEA2	DEA3
x_{1i} = **IHP**	**0.00882391**	-0.04316922	-0.00083105
	(0.00332321)*	**(0.04373269)***	(0.90406868)
x_{2i} = **Water Access**	-0.00140627	**0.0108249**	**0.00640271**
	(0.24363199)	(0.22936561)	**(0.04017364)***
x_{3i} = **Adult Literacy**	0.00390498	**-0.01281794**	**-0.00026348**
	(0.00855592)*	(0.22189725)	(0.93973893)
x_{4i} = **Urbanization rate**	**0.00001083**	**0.00009111**	-0.000994
	(0.99191889)	(0.99089173)	(0.7112497)
α_0 = **Constant**	-0.32031493	2.31084022	-0.19808483
	(0.19713822)	(0.21186121)	(0.74675062)

*Significant value at 5%.
The results of regression give a good quality of adjustment for the three models. The relation is linear and the regression model is robust.

We can note that the most significant results of the coefficients are initially obtained by DEA1 model (at 5%), followed by DEA2 and DEA3.
a) With regard to the economic variable selected, i.e. the IHP, it is significant for DEA1 and DEA2 models. We find a surprising result: an inverse correlation between poverty and inefficiency. It appears possible that we can obtain poor results even if we devote important resources to health.
b) The socio medical variable is significant only in DEA3 model, but has the awaited sign for DEA2 and DEA3 models.
c) The education variable is a determining factor for DEA1. The result is surprising, when the level of education increases the inefficiency increases too (the result should be re-examined).
d) Concerning the demographic variable, we find a positive correlation between this variable and inefficiency (DEA1 and DEA2). This result can be explained by the reason of the bad care services due to the high number of patient in urban areas. This is not confirmed in DEA3 Model.

5. Discussion of Findings

The results show that the efficiency scores of the health sectors in the countries of the sample are on average of 74.5% for the three Models.

In DEA1 and DEA3 Models, the most efficient countries are those which have the weakest total health expenditure: Angola, Benin, Cap Verde, Kenya, Mozambique, Nigeria, and Tanzania (excepted Qatar). They are considered the most efficient in the

production of these services. They have a score equal to the unit.For DEA2 and DEA3 Models we notice, as seen in table 2, that the efficiency scores in the African countries are higher than in those in the other countries. Indeed, these countries are efficient (according to the two methods) at 82.4% against 48.7% for the Arab countries whereas the efficiency scores of all the countries (Arab and African) is 66%.

This performance of the African countries could be explained by the employment of paramedical staff, more useful in dealing with certain diseases than physicians equally the importance of the care provided by international NGO's in these countries is to be taken into account.

In addition, this efficiency did not succeed in achieving the goals awaited as regards health improvement. The African countries remain inefficient compared to the Arab countries. We can explain this by the prevalence of the AIDS that decrease noteworthy the life expectancy in these countries.We notice that the socio-economic indicators chosen explain the inefficiency of the systems of health. This leads us to examine their effects in order to understand their influence, seeing that we ended to results not in conformity with the awaited logic.

6. Conclusion

The differences noted in the efficiency scores according to the selected combination of inputs and outputs show the sensitivity of the method to the choice of models. Beyond this purely descriptive aspect, we introduced certain explanatory elements of the efficiency scores by establishing a relation between the level of efficiency and certain variables likely to collect the structural constraints specific to each country. These efficiency scores were used to carry out international comparisons of the outputs of the health systems and came out with the conclusion that the countries with a low expenditure in health in relation to the GDP tend to reach a better efficiency (in DEA3).

This study showed that the increase of the inputs will lead to reducing the efficiency of these systems. The most significant conclusion which emerges is that what matters is not increasing resources in order to improve efficiency but on the contrary it is necessary to be careful at the time of the decision-making of their increase, especially when they are already initially high (DEA2 and DEA3).

Another significant point to rise consists in the fact that efficiency does not necessarily imply effectiveness. This was proved with the case of the African countries that are considered as efficient but were unable to produce a life expectancy higher than that of the least efficient countries (in DEA2 and DEA3 Models).

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