ISSN: 2162-6359

International Journal of Economics and Management Sciences

Vol. 1, No. 3, 2011, pp. 90-104

MANAGEMENT JOURNALS
managementjournals.org

COMPARING MACROECONOMIC PERFORMANCE OF OIC MEMBER COUNTRIES

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ABSTRACT

In this study, a mathematical programming based technique in productivity management, known as data envelopment analysis, DEA is used to estimate how well the nations of the Organization of the Islamic Cooperation, OIC utilize their resources. A high growth rate (as indicated by the change in gross domestic product), a low rate of inflation, a low rate of unemployment and a favorable trade balance are four main targets or objectives of a nation's macroeconomic policy makers. Based on selected macroeconomic input and output indicators, we apply three versions of an output-oriented DEA model under the assumption of variable returns to scale to assess the relative macroeconomic performance of 54 member countries for the period 2003-2007. The three versions produced consistent results. Three fuel-exporting countries and four least-developed countries top the performance list with Iran and Yemen at the bottom. Of a subset of 33 fuel-exporting and medium-developed countries, nine (seven and two respectively) top the list. The results were analyzed to identify the possible merits of efficiency and sources of inefficiency.

Keywords: *macroeconomic performance, data envelopment analysis, linear programming.*
2000 MS Classification: *90C05, 90C32*
JEL Classification: *C61, O11*

1. INTRODUCTION

Managing an economy is no easy task. A high growth rate as indicated by the change in gross domestic product, GDP, a low rate of inflation as depicted by the change in consumer price index, CPI, a favorable trade balance and a high rate of employment are main targets or mission of a nation's macroeconomic policy maker. The sum of inflation rate and unemployment rate is associated with the undesirable Okun's *misery index* (Lovell *et al*., 1995) and provides a pessimistic measure of the macroeconomic performance of a nation. Thus the performance of a nation needs to be assessed and evaluated periodically so that any shortcoming or underachievement can be identified, analyzed and appropriate steps taken to remedy it.

Many studies on macroeconomic and development performance of regions, cities and nations have been conducted and reported in the literature. Charnes, *et al.* (1989) used DEA to evaluate the economic performance of 28 selected Chinese cities following the government's program of economic development. Sueyoshi (1992) extended the study to measuring and evaluating the industrial performance which also explores the returns to scale of these cities. The macroeconomic performance of ten Asian economies with special attention to Taiwan was studied and summarized by Lovell (1995) in terms of the four main output indicators. Despotis (2005) extended the applicability of the DEA model with variable returns to scale to estimate the relative efficiency of countries in Asia and the Pacific in converting incomes to human development. Other regional studies utilizing DEA include

Karkazis and Thanassoulis (1995), Martic and Savic (2001) and Mohamad (2007). In most of these regional studies, the units under evaluation such as nations, cities and regions are nearly homogeneous in terms of their socio-economic background and geographical location.

This study seeks to assess the macroeconomic performance of 54 (out of the 57) selected member countries of the Organization of the Islamic Cooperation (formerly known as Organization of the Islamic Conference), OIC for the period 2003- 2007, by utilizing the output-oriented DEA model under the assumption of variable returns to scale, VRS. The complexity of OIC as the second largest inter-governmental organization after the United Nations motivates us to undertake this study. The 57 member countries are dispersed over a large geographical region spanning over four continents. As a group, the OIC countries account for one-sixth (or 16.67%) of the world's area, extending from Albania (Europe) in the North to Mozambique (Africa) in the South, and from Guyana (Latin America) in the West to Indonesia (Asia) in the East. OIC community also exhibits high level of income divergence with huge gap between the rich and the poor countries. Based on 2007 statistics, the average GDP per capita for OIC as a group is US$2595, ranging from a low US$206 (for Guinea-Bissau) to a high US$72849 (for Qatar) (SESRIC, 2008; Central Intelligence Agency, 2010). This reflects a difference of 354 times between the richest and the poorest. Thus a study of an organization with such high level of heterogeneity is likely to produce interesting (and probably contradicting) findings.
The rest of the paper is organized as follows. The next section provides the DEA methodology related to the three versions employed in the study – the extended multiplier form, the helmsman model of Lovell (1995) and the *generic* input-output model of Ramanathan (2006). This is followed by the macroeconomic data utilized for the study and the results, interpretations and policy implications. The final section concludes with highlights for future research.

2. THE DEA METHODOLOGY

The mathematical programming formulation presented below was originally derived in Charnes *et al.,* (1978) and is normally referred to as the "CCR ratio form of DEA". Suppose there are S decision making units (DMUs) to be investigated, each utilizes m inputs to produce n outputs. Further, let DMU_k, $(1 \le k \le S)$ uses a combination of m inputs, denoted by $X_k = \{X_{k1}, X_{k2}, ..., X_{km}\}$ to produce n outputs, denoted by $Y_k = \{Y_{k1}, Y_{k2}, ..., Y_{kn}\}$. The productivity or relative efficiency, E_k for DMU_k is defined as

$$E_k = \frac{\sum_{j=1}^{n} h_j Y_{kj}}{\sum_{i=1}^{m} c_i X_{ki}}, \quad k = 1, 2, \ldots, S, \tag{1}$$

where the weights c_i represents the price (i.e the value or shadow cost) of one unit of input X_{ki}, $1 \le i \le m$, $\forall$ $k = 1, 2, \ldots, S$, and h_j represents the price (or the value of the contribution) of one unit of output Y_{kj}, $1 \le j \le n$, $\forall$ $k = 1, 2, \ldots, S$.
The focus of most studies on performance is to seek possible improvements in the levels of outputs. This calls for the formulation of an equivalent dual output-oriented DEA model. This form is given by

(DLP1) maximize Ω_0

subject to

$$-X_{0i} + \sum_{k=1}^{S} X_{ki}\lambda_k \le 0, \quad i = 1,2, \ldots, n, \tag{2}$$

$$-Y_{0j}\Omega_0 + \sum_{k=1}^{S} Y_{kj}\lambda_k \ge 0, \quad j = 1,2, \ldots, m, \tag{3}$$

$$\lambda_k \ge 0, \quad k = 1,2,...,S,$$

Ω_0 unconstrained.

(DLP1) is the output-oriented model under constant return to scale, CRS. For evaluation under the assumption of variable return to scale, VRS an additional convexity constraint is imposed on λ_k, (Cooper *et al*., 1999) such that

$$\sum_{k=1}^{S} \lambda_k = 1. \tag{4}$$

This results in the formation of a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency scores which are greater than or equal to those obtained under the assumption of CRS. The difference in the technical efficiency scores under the two assumptions of returns to scale is mainly attributable to scale inefficiency. The output-oriented model exhibits some special features:

- The technical efficiency score, $\theta_0 = 1/\Omega_0$, such that $1 \le \Omega_0 < \infty$ since $0 \le \theta_0 \le 1$.
- Proportional improvement in outputs for inefficient DMUs is given by $\Omega_0 - 1$.
- The number of peers among efficient DMUs for an inefficient DMU under evaluation is not more than the number of constraints which corresponds to the total number of inputs and outputs. These peers can be identified from the non-zero λ_k values.
- Each constraint is associated with an input (or output). This provides ease of selecting combinations of input-output mix by enabling/disabling the relevant constraint(s).

The objective here is to seek maximum Ω_0 that increases Y_{0j} proportionally to $\Omega_0 Y_{0j}$, $\forall j$, while retaining the input level of DMU$_0$ no greater than X_{0i}. $\forall i$. Improvement or movement towards efficient frontier by inefficient DMUs can be identified by inspecting the system of the following equations,

$$\sum_{k=1}^{S} X_{ki}\lambda_k + t_i^- = X_{0i}, \quad i = 1,2, \ldots, n, \tag{5}$$

and

$$\sum_{k=1}^{S} Y_{kj}\lambda_k - t_j^+ = Y_{oj}\Omega_0, \quad j = 1,2, \ldots, m. \tag{6}$$

where t_i^-, t_j^+, $\forall i, j$ are slacks.

For an inefficient DMU$_0$, say, the projected output on the efficient frontier is as dictated by its peers (identified from $\lambda_k \neq 0, \forall k$) and given by $\sum_{k=1}^{S} Y_{kj}\lambda_k$, $j = 1,2,...,m$. This can be achieved by proportional improvements of $(\Omega_0 - 1)$ in all outputs plus additional amount (termed as slack movements) of t_j^+ in output Y_{0j} whenever $t_j^+ \neq 0$. On the input side, equation (5) suggests that the level of input X_{0i}, $\forall i$ can further be reduced by an amount of t_i^- whenever $t_i^- \neq 0$ to those dictated by the peers, that is $\sum_{k=1}^{S} X_{ki}\lambda_k$. Thus, $(\Omega_0 - 1)Y_{0j} + t_j^+$ is a measure of *under-achievement* of output Y_{0j}, $j = 1,2,...,m$, experienced by DMU$_0$, while t_i^- reflects the *over-utilization* of input X_{0i}, $\forall i$. The projected position on (and the movement to) the efficient frontier can be expressed as

$$\hat{X_{0i}} = \sum_{k=1}^{S} X_{ki}\lambda_k^* = X_{0i} - t_i^{-*}, \; i = 1, 2, \ldots, n, \tag{7}$$

and

$$Y_{0j}^{\wedge} = \sum_{k=1}^{S} Y_{kj}\lambda_k^* = Y_{0j}\Omega_0^* + t_j^{+*}, \quad j = 1,2, \ldots, m. \tag{8}$$

where $(X_{0i}^{\wedge}, Y_{oj}^{\wedge}, \forall i, j)$ is the position of the composite virtual efficient DMU on the frontier, and $(\Omega_0^*, t_i^{-*}, t_j^{+*}, \lambda_k^*)$ is the optimal solution of (DLP1) for the decision making unit under evaluation.

In this study, we employed three versions of (DLP1) under the assumption of VRS in assessing the macroeconomic performance of the selected 54 member countries of OIC.

Model 1. This corresponds to the actual version of (DLP1) with suitable set of selected input and output indicators,

$$\left.\begin{aligned} &\text{maximize} \quad \Omega_0 \\ &\text{subject to} \\ &\quad -X_{0i} + \sum_{k=1}^{S} X_{ki}\lambda_k \le 0, \quad i = 1,2, \ldots, n, \\ &-Y_{0j}\Omega_0 + \sum_{k=1}^{S} Y_{kj}\lambda_k \ge 0, \quad j = 1,2, \ldots, m, \\ &\quad \sum_{k=1}^{S} \lambda_k = 1. \\ &\quad \lambda_k \ge 0, \quad k = 1,2,\ldots,S, \end{aligned}\right\} \tag{9}$$

Model 2. Following Lovell (1995) and Lovell *et al.*(1995), in the production of outputs each country uses only one input, its macroeconomic decision-making apparatus, a bureaucracy collectively referred to as *helmsman*. And each country uses exactly one helmsman. Thus $X_k = 1$, for all $k = 1, 2, \ldots, S$. The equivalent model is thus

$$\left.\begin{aligned} &\text{maximize} \quad \Omega_0 \\ &\text{subject to} \\ &-Y_{0j}\Omega_0 + \sum_{k=1}^{S} Y_{kj}\lambda_k \ge 0, \quad j = 1,2, \ldots, m, \\ &\quad \sum_{k=1}^{S} \lambda_k = 1 \\ &\quad \lambda_k \ge 0, \quad k = 1,2,\ldots,S, \end{aligned}\right\} \tag{10}$$

In this version, the input constraint $-X_{0i} + \sum_{k=1}^{S} X_{ki}\lambda_k \le 0, \quad i = 1,2, \ldots, n,$ becomes $-X_0 + \sum_{k=1}^{S} X_k\lambda_k \le 0,$ since $n = 1$, and reduces to $\sum_{k=1}^{S} \lambda_k \le 1,$ which is redundant since under VRS, $\sum_{k=1}^{S} \lambda_k = 1$.

Model 3. Following the methodology adopted in Ramanathan (2006) terms like "inputs" and "outputs" are largely generic. Performance of undesirable attributes (such as inflation) is considered inputs and performance of desirable attributes (such as economic growth) is considered outputs. Thus, the input and output variables in model 3 represent undesirable and desirable attributes respectively.

3. DATA ACQUISITION

The OIC is an international inter-governmental organization with a permanent delegation to the United Nations. It was established on 25 September 1969, following the loss of Muslim holy sites in Jerusalem. According to its charter, the OIC aims to preserve Islamic social and economic values; promote solidarity amongst member states; increase cooperation in social, economic, cultural, scientific, and political areas; uphold international peace and security; and advance education, particularly in the fields of science and technology. Over the last forty years, the membership has grown from its founding members of 25 to 57 countries.

Table 1 lists the 57 member countries (which for reference purposes are denoted as DMU01, DMU02,…, DMU57) according to their economic attributes and regional locations. Of the fifteen fuel-exporting countries (OIC-FEC), ten are from Middle East and North Africa (MENA) region. Twenty medium-developed countries (OIC-MDC) are scattered on the four continents while the remaining twenty-two are grouped under least-developed countries (OIC-LDC), of which seventeen belong to Sub-Saharan Africa region with low income per capita. In terms of gross domestic product (GDP) per capita, only seven nations are categorized as high income group. Except for Brunei (from East Asia and Pacific), all countries in the high income group are OIC-FEC from MENA. The upper and lower-middle income group is dispersed over a larger region, while the majority of lower-income group is concentrated in the Sub-Sahara Africa region. In view of this non-homogeneity, results produced by any performance assessment on these groups should be handled with caution.

We apply the three versions of the model discussed above to the OIC member countries for the period 2003-2007. The macroeconomic performance of a country can be measured by the growth rate of its GDP, the level of employment, the movement of consumer price index (CPI) and its trade balance, amongst others. The government can use fiscal and monetary policies to achieve these macroeconomic objectives. Fiscal policy involves the use of government spending, taxation and borrowing to influence both the pattern of economic activity and also the level and growth of aggregate demand, output and employment. Monetary policy, on the other hand involves the use of interest rates to control the level and rate of growth of aggregate demand in the economy. However, data availability is a problem. Thus, for the purpose of our study one input and four output indicators are chosen to characterize and reflect the macroeconomic structure of the 54 OIC member countries. These indicators are defined as follows,

- Input (X): Total government consumption expenditure as a percentage of GDP which in some studies acts as control instrument. We employ this input indicator only for the multiplier model 1.
- Output 1 ($Y1$): The annual rate of growth of GDP, expressed in percentage.
- Output 2 ($Y2$): The ratio of merchandise exported to merchandise imported as a proxy for balance of trade.
- Output 3 ($Y3$): The rate of inflation as indicated by the rate of change of the CPI.
- Output 4 ($Y4$): The total labor participation rate (measured as percentage of total population ages 15 – 64 years) which refers to *the total population ages 15 – 64 years old that is economically active and supplying labor for the production of goods and services during a specified period* [9]. This indicator is chosen due to incomplete availability of data on the rate of employment.

The selected macroeconomic indicators for the year 2007 are depicted in Table 2 together with their data summary statistics. The main source of reference is the SESRIC database at http://www.sesrtcic.org/index_databases.php. Except for the balance of trade, all other indicators exhibit relatively high standard deviations, especially the labor participation rate. The percentage of GDP allocated to government final consumption expenditure varies from a low 4.52% (Lebanon) to a high 30.61% (Chad) with an average of 14.72%. Twenty-five nations (about 43.9%) record final consumption expenditure above average. Except Azerbaijan, all OIC-FEC's final consumption expenditures exceed 10% of their incomes (the highest being Brunei at 25.57% as compared to Azerbaijan's 6.53%).

The highest growth is by Azerbaijan (23.40%) while Comoros records a negative growth of -1.11%. The average economic growth for OIC is 5.59% with a standard deviation of 3.84%. Only four countries record two-digit percentage growth rate. However, these four high-growth countries do not contribute to the ten OIC high-producing countries which account for 73% of the total OIC output in 2007 [9]. As a group, OIC countries record a small trade balance surplus in 2007. Five members of OIC-FEC exhibit a significant trade balance (of more than 2.0). These are Azerbaijan, Brunei, Kuwait, Libya and Nigeria. Libya records the highest trade balance of 3.39 while Palestine records the lowest at 0.17, followed by Somalia (0.18), Uganda (0.33) and Afghanistan (0.37). These poor trade performers are also considered as politically unstable entities.
The average rate of inflation for the OIC countries is about 6.65% which is considerably higher than the world's average of 3.90% and the average recorded by the developed and developing countries (2.20% and 6.30% respectively). The worst hit is Guinea (22.86%), followed by Qatar (13.76%), Tajikistan (13.17%) and Afghanistan (13.03%) while two OIC-LDC, Burkina Faso and Chad recorded a negative rate of -0.25% and -8.81% respectively. No data is available for three countries (Iraq, Palestine and Somalia). In fact, in Somalia it is reported that *businesses print their own money, so inflation rate cannot be easily determined* (http://www.indexmundi.com/somalia/inflation_rate(consumer_price).html).

The last indicator is total labor participation rate (ages 15 – 64 years old). The highest is 85.9% as recorded by Uganda, followed by Guinea (84.1%), Burkina Faso (83.3%) and Mozambique (82.9%). These are OIC-LDC from Sub-Sahara Africa region. Eight nations record a labor participation rate of less than 50%, the two lowest being Palestine (40.8%) and Iraq (41.8%). However, as a group, on average 62.72% of the total population in age group 15 – 64 years is economically active and contributing to the labor market.
Due to the non-availability of data on the rate of inflation for Iraq, Palestine and Somalia, we focus our study on the remaining 54 member countries. The indicators of input, balance of trade and labor participation rate take a strictly positive value for all observations. The rate of economic growth and inflation indicators take on negative value for some observations, and DEA is not capable of handling negative values. Thus, for consistency all indicators are normalized on a scale of [1, 10] such that the followings hold (Mohamad, 2007).

- For indicators whose large positive values are desirable ($Y1$, $Y2$ and $Y4$), we adopt the transformation

$$X_{nor} = \frac{9(X_{act} - X_{min})}{X_{max} - X_{min}} + 1 \qquad (11)$$

where X_{nor} is the value of the normalized indicator,
X_{act} is the actual value of the indicator,
X_{max} is the maximum value of the indicator,
X_{min} is the minimum value of the indicator.
This transformation ensures that $X_{nor} \in [1, 10]$.

- For indicators whose small values are preferable (such as $Y3$), we adopt the transformation

$$X_{nor} = \frac{9(X_{max} - X_{act})}{X_{max} - X_{min}} + 1 \qquad (12)$$

where X_{nor} is the value of the normalized indicator,
X_{act} is the actual value of the indicator,
X_{max} is the maximum value of the indicator,
X_{min} is the minimum value of the indicator.
This transformation ensures that $X_{nor} \in [1, 10]$.

4. RESULTS AND INTERPRETATIONS

4.1 Technical Efficiency

We use linear programming software, LINDO to solve the DEA model under the assumption of VRS. This amounts to running the program 162 times for each year. The average relative technical efficiency scores (which act as performance indicators for each nation) are presented in Table 4. The results obtained are consistent for the three models with model 1 producing a relatively higher score, followed by model 2 and model 3. The mean absolute deviations, MAD between each model is less than 0.5% with an average score of 0.8864, 0.8288 and 0.7325 respectively. Model 1 suggests 14 nations are technically efficient in converting the input to outputs. However, in the absence of the input indicator, both model 2 and model 3 shortlist seven nations as being technically efficient.

These seven nations are three OIC-FEC and four OIC-LDC, each exhibiting superiority in one or more indicators or combinations of indicators. Azerbaijan (DMU04) records the highest rate of growth of GDP of 23.39% in 2007 (20.95% and 13.25% in 2006 and 2005 respectively) while maintaining a low level of total government consumption expenditure at 6.53% of GDP. It also experiences a favorable trade balance with export of merchandise and services more than double the import of merchandise and services. However, its rate of inflation of 16.6% is above the group's average of 6.65%. Libya (DMU29) is another top performer, mainly due to its superiority in balance of trade where the values of its exports more than triple the values of its imports. Its GDP growth rate of 6.8% is above the group's average of 5.59%. However, its labor participation rate of 52.7% is below the group's average of 62.72%. Qatar is another OIC-FEC performer shortlisted as relatively technically efficient despite exhibiting a relatively high rate of inflation (13.76%) and total government consumption expenditure (19.50%). These drawbacks are outweighed by the combination of the other three indicators – a high GDP growth rate of 14.2%, a favorable trade balance of 1.89 and an above average labor participation rate of 77.2%.

Four members of OIC-LDC (Burkina Faso, Chad, Guinea and Uganda) are jointly classified as top performers. Burkina Faso and Chad are the only two OIC member countries experiencing negative rate of inflation in 2007. Both also record relatively high labor participation rate. Guinea, however, records the highest rate of inflation of 22.86%. But, its score for the fourth indicator of 84.1% is second highest in the group, behind Uganda who leads the group with 85.9%. Three members of OIC-MDC (Indonesia, Lebanon and Suriname) are found to be technically efficient under Model 1 but not under Model 2 or Model 3. This is strongly attributable to their favorably low input values of 6.68%, 4.52% and 4.67% respectively, which are much lower than the group's average of 14.72%. Thus, it appears that superiority in one or more indicators can outweigh other shortcomings or nonperforming attributes when employing DEA methodology with no weight restriction.

Table 4 lists the weights associated with the indicators as given by the dual values of Model 2. Two countries, namely Azerbaijan and Qatar had the contributions from all four indicators; two countries, namely Guinea and Uganda had contributions from three contributors; two countries, namely Burkina Faso and Chad had contributions from two indicators while one country, namely Libya had contribution from one indicator only. The contributions of technical efficiency for Azerbaijan and Qatar come from the growth rates and the labor participation rate, amounting to more than 76.8%. A low normalized inflation rate only contributes 10.7% and 13.8% to the technical efficiency. Guinea and Uganda capitalize on labor participation rate giving it a contributing factor of 89.9% and 91.1% respectively. The normalized inflation rate only accounts for 0.3% and 3.3% to the technical efficiency scores respectively. The technical efficiency score for Burkina Faso comes from two sources, a high normalized inflation rate (37.6%) and a relatively high labor participation rate (62.4%). No contribution is made by growth rate and balance of trade. Having the highest normalized inflation rate contributes 58.2% to Chad's technical efficiency score. The other 41.8% comes from balance of trade. No contribution is made by growth rate and labor participation rate. Libya monopolizes on the balance of trade, making it sole contributor to technical efficiency score. Thus, with the exception of Libya, all other efficient DMUs take account of rate of inflation but at a manageable level.

Next, we look at the relatively poor performers and try to identify the sources of their inefficiencies. Based on the average of the three efficiency scores, the bottom four are Egypt (0.6497), Turkey (0.6289), Iran (0.5508) and Yemen (0.4897). Despite achieving a reasonable growth rate, all four nations perform badly in two of the output indicators, *Y*3 and *Y*4. The rates of inflation recorded (10.95% for Egypt, 18.4% for Iran, 8.76% for Turkey and 12.48% for Yemen) exceeds the group's average of 6.65%, while the labor participation rate of 47.3%, 53.5%,

47.5% and 43.9% respectively, is among the lowest. With the exception of Iran, the other three countries also record unfavorable trade balance of less than unity. The main peers for these poor performers are DMU04 (Azerbaijan) and DMU11 (Chad) which exhibit superiority in *Y*1 and *Y*3 respectively.

For a more homogenous comparison, we omit the twenty-one OIC-LDC, and use Model 2 to assess the remaining 33 countries belonging to the OIC-FEC and OIC-MDC subgroups. Results are presented in Table 5 which also includes the peers for the inefficient DMUs. The efficient DMUs are ranked according to the peer counts, the number of times a DMU appears as a peer for the inefficient DMUs, while the inefficient DMUs are ranked according to their efficiency scores.

Seven OIC-FEC and two OIC-MDC top the performance list, with DMU30 (Malaysia) ranked first due to its high peer counts of 15. This is followed by five OIC-FEC members (Turkmenistan, Azerbaijan, Brunei, Gabon and Qatar). Another OIC-MDC top performer is Cameroon which is ranked seventh, followed by Libya and United Arab Emirates. On average, the OIC-FEC group records a relatively higher technical efficiency score of 0.9053 than the OIC-MDC group (of 0.8795). Although the bottom performer is from OIC-FEC (Iran at 0.5452), the next twelve bottom performers are from OIC-MDC group.

4.2 Identifying the sources of inefficiency

In addition to providing the relative technical efficiency scores, DEA also identifies sources of inefficiency inherent in the inefficient DMUs and projects targets or levels to be adopted by these DMUs if they are to be on the efficient frontier. To illustrate the computation involved, we will consider two selected inefficient DMUs (DMU05 Bahrain and DMU51 Tunisia). Their respective results are given in Table 6.

DMUs with zero slacks

For these DMUs, their projected values are fully dictated by their peers and given by the systems of equations (7) and (8) with $t_i^- = 0,\ \ t_j^+ = 0,\ \ \forall i, j.$ Thus, for DMU05 (Bahrain), for example, we have $\Omega_5^* = 1.00519$, giving

$$X_{51}^{\wedge} = X_{51} = 1,$$
$$Y_{5j}^{\wedge} = 1.00519 Y_{5j} = Y_{5j} + 0.00519 Y_{5j},\ \ j = 1,2,3,4.$$

This means all outputs are to be proportionally increased by 0.519% in all directions. These incremental values are associated with the radial movements and are given under the fourth column in Table 6. The projected values are the sum of the original values and their respective radial movements. These are recorded under the seventh column and represent the position of an *efficient virtual composite DMU (of peers)* on the efficient frontier which benchmarks the position of the inefficient DMU.

DMUs with non-zero slacks

Next, we turn to DMU51 (Tunisia). The result indicates the presence of a non-zero variable slack, $t_2^+ = 0.5818$ and $t_4^+ = 2.8083$ associated with outputs Y_2 and Y_4 respectively. The position on the frontier is achieved by a radial movement of 3.612% of all outputs, followed by additional axial movements of 0.5818 and 2.8083 for outputs Y_2 and Y_4 respectively. A movement in all outputs alone is not sufficient to project the DMU51 onto the efficient frontier. Additional slack movements for outputs Y_2 and Y_4 are required for the DMU51 to match their virtual composite DMUs on the frontier. We can represent the results of normalized indicators for DMU51 in terms of equations (7) and (8) as follows,

$$\begin{cases} X^{\wedge}_{51(1)} = X_{51(1)} - t_1^- = 1 - 0 = 1, \\ Y^{\wedge}_{51(1)} = 1.036121Y_{51(1)} - t_1^+ = (3.69 + 0.1333) + 0.00 = 3.8233, \\ Y^{\wedge}_{51(2)} = 1.036121Y_{51(2)} + t_2^+ = (3.23 + 0.1167) + 0.58177 = 3.9284, \\ Y^{\wedge}_{51(3)} = 1.036121Y_{51(3)} + t_3^+ = (6.60 + 0.2384) + 0.00 = 6.8384, \\ Y^{\wedge}_{51(4)} = 1.036121Y_{51(4)} + t_4^+ = (2.50 + 0.0903) + 2.80826 = 5.3986. \end{cases}$$

A similar analysis can be conducted for all other inefficient DMUs (nations) in order to identify their sources of inefficiencies and the position of the composite efficient unit they are compared with.

4.3 Policy implication

On average, the technical efficiency scores for the OIC countries for the period 2003-2007 are relatively high, averaging 0.8159 for all fifty-four countries and 0.9053 for OIC-FEC-MDC countries. However, some policy measures with the aim of strengthening economic cooperation amongst member countries are needed.

Most of the non-fuel producers are agriculture based economies. As demand for food is likely to continue to increase more rapidly, policies that have the potential to improve supply over time are mostly needed. Poor agricultural technology is the main factor that hinders agricultural output. Availability of water is a vital factor in maintaining and increasing agricultural production. Thus, policy measures to improve facilities and land utilization are critical. Policy measures to improve such infrastructure could generate a considerable expansion in supply over time. Therefore, more efforts should be exerted in order to improve the infrastructure in agricultural sector through more investments, both public and private, and to create a favorable environment for foreign investment, including from the fuel-exporting members, in agricultural sector.

The high share of industry in the total output of many OIC countries, particularly in the fuel-exporting countries, does not reflect the high level of industrialization in the countries, since the production of oil and gas are classified as industrial activity. The low share of manufacturing in total output of many OIC countries is a clear indicator of the low level of industrialization in the countries. Improving the manufacturing facilities in these countries is utmost importance. The diversification of their production base would enable them to increase the value-added and quality of their products, helping them become less dependent on manufacturing imports and thereby increasing their trade balance. In addition, investments in agro-industry are another policy action in addressing agricultural and industrial development and unemployment challenges.

Inflationary pressures are on the rise. It has the potential effect of distorting macroeconomic and financial stability in many countries, including the OIC members. Thus, a prudent monetary policy becomes necessary in order to control inflation in the medium term.

The continued internal conflicts in some member countries, particularly in Africa, have undoubtedly serious negative impact on all aspects of life. It has impeded any efforts towards furthering the potential for economic development. It is hoped that such a conflict will come to an end. It is the role of member countries to try and find a solution acceptable to all parties. Thus, actions by governments, NGOs and international organizations are required to implement appropriate policies or programs to support the economic development in the OIC member countries.

5. CONCLUSIONS

In this study we utilized the DEA methodology and illustrated its applicability in measuring, assessing and analyzing the macroeconomic performance of OIC member countries for the period 2003-2007. Three versions of the output-oriented model produced consistent results. Three nations were not included in the sample due to the absence of data on rate of inflation. When assessing the 54 member countries, the top performers were dominated by member of sub-groups OIC-FEC and OIC-LDC, attributable mainly to the superiority in one or more indicators considered in the assessment. For an alternative homogenous assessment the sample was reduced to include only members of sub-groups OIC-FEC and OIC-MDC. Seven members of OIC-FEC and two members of OIC-MDC were classified as best performers with Malaysia heading the list.

The paper also highlights how DEA can be used to estimate and identify inefficiencies and their sources. For inefficient units, DEA also identifies the associated efficient virtual composite units on the frontier comprising of relevant group of peers of efficient units and the directions to these projected composite units. This information is important and can aid the policy-makers in allocating resources more efficiently and identifying directions for improvement.

The study is by no means complete. Due to limited space and time, many important aspects of DEA have not been addressed. A revised DEA model with additional explanatory variables capturing essential features of the country's economic, fiscal, monetary, social and environmental aspects might produce valuable information in identifying the variations and shortcomings inherent in the macroeconomic performance. Others include the multiplier or weight restrictions such as the imposition of assurance regions (AR), issues of congestion, the restriction of integer-value variables, general multiple criteria decision making such as GoDEA and integrated analytic hierarchy process (AHP), dynamic changes in efficiency over time involving technological change and frontier shift (a study in Malmquist's total factor productivity), and random variable data chance constrained programming for the formulation of probability-based stochastic DEA model. These topics are receiving significant attention in literatures and provide directions and avenues for future research.

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Table 1. OIC member countries according to categories and locations.

DMU*	Country	Group[1]	Income[2]	Region[3]
DMU01	Afghanistan	LDC	Low	South Asia
DMU02	Albania	MDC	Lower-Middle	Europe & Central Asia
DMU03	Algeria	FEC	Lower-Middle	MENA
DMU04	Azerbaijan	FEC	Lower-Middle	Europe & Central Asia
DMU05	Bahrain	FEC	High	MENA
DMU06	Bangladesh	LDC	Low	South Asia
DMU07	Benin	LDC	Low	Sub-Sahara Africa
DMU08	Brunei	FEC	High	East Asia & Pacific
DMU09	Burkina Faso	LDC	Low	Sub-Sahara Africa
DMU10	Cameroon	MDC	Lower-Middle	Sub-Sahara Africa
DMU11	Chad	LDC	Low	Sub-Sahara Africa
DMU12	Comoros	LDC	Low	Sub-Sahara Africa
DMU13	Cote d'Ivoire	MDC	Low	Sub-Sahara Africa
DMU14	Djibouti	LDC	Lower-Middle	MENA
DMU15	Egypt	MDC	Lower-Middle	MENA
DMU16	Gabon	FEC	Upper-Middle	Sub-Sahara Africa
DMU17	Gambia	LDC	Low	Sub-Sahara Africa
DMU18	Guinea	LDC	Low	Sub-Sahara Africa
DMU19	Guinea-Bissau	LDC	Low	Sub-Sahara Africa
DMU20	Guyana	MDC	Lower-Middle	Latin A & Caribbean
DMU21	Indonesia	MDC	Lower-Middle	East Asia & Pacific
DMU22	Iran	FEC	Lower-Middle	MENA
DMU23	Iraq	FEC	Lower-Middle	MENA
DMU24	Jordan	MDC	Lower-Middle	MENA
DMU25	Kazakhstan	MDC	Upper-Middle	Europe & Central Asia
DMU26	Kuwait	FEC	High	MENA
DMU27	Kyrgyzstan	MDC	Low	Europe & Central Asia
DMU28	Lebanon	MDC	Upper-Middle	MENA
DMU29	Libya	FEC	Upper-Middle	MENA
DMU30	Malaysia	MDC	Upper-Middle	East Asia & Pacific
DMU31	Maldives	LDC	Lower-Middle	South Asia
DMU32	Mali	LDC	Low	Sub-Sahara Africa
DMU33	Mauritania	LDC	Low	Sub-Sahara Africa
DMU34	Morocco	MDC	Lower-Middle	MENA
DMU35	Mozambique	LDC	Low	Sub-Sahara Africa
DMU36	Niger	LDC	Low	Sub-Sahara Africa
DMU37	Nigeria	FEC	Low	Sub-Sahara Africa
DMU38	Oman	FEC	High	MENA
DMU39	Pakistan	MDC	Low	South Asia
DMU40	Palestine	MDC	Lower-Middle	MENA
DMU41	Qatar	FEC	High	MENA
DMU42	Saudi Arabia	FEC	High	MENA
DMU43	Senegal	LDC	Low	Sub-Sahara Africa
DMU44	Sierra Leone	LDC	Low	Sub-Sahara Africa
DMU45	Somalia	LDC	Low	Sub-Sahara Africa
DMU46	Sudan	LDC	Lower-Middle	Sub-Sahara Africa
DMU47	Suriname	MDC	Upper-Middle	Latin A & Caribbean
DMU48	Syria	MDC	Lower-Middle	MENA
DMU49	Tajikistan	MDC	Low	Europe & Central Asia
DMU50	Togo	LDC	Low	Sub-Sahara Africa
DMU51	Tunisia	MDC	Lower-Middle	MENA
DMU52	Turkey	MDC	Upper-Middle	Europe & Central Asia
DMU53	Turkmenistan	FEC	Lower-Middle	Europe & Central Asia
DMU54	Uganda	LDC	Low	Sub-Sahara Africa
DMU55	United Arab Emirates	FEC	High	MENA
DMU56	Uzbekistan	MDC	Low	Europe & Central Asia
DMU57	Yemen	LDC	Low	MENA

Notes:

1) FEC: Fuel-exporting country , LDC : Least-developed country
   MDC: Medium-developed country.
2) Low income (GDP per capita < US$650) , Lower-middle income (GDP per capita <US$2000) ,
   Upper-middle income (GDP per capita < US$9999), High income (GDP per capita > US$10000).
3) MENA : Middle East and North Africa countries.

* DMU refers to *decision making unit*.

Source: *Annual Economic Report on The OIC Countries,* 2008. Statistical, Economic and Social Research Training Centre for Islamic Countries (SESRIC).

Table 2 Selected macroeconomic statistics, OIC member countries, 2007

DMU	Country	X1	Y1	Y2	Y3	Y4
DMU01	Afghanistan	10.12	12.43	0.37	13.03	59.6
DMU02	Albania	12.36	6.01	0.51	2.94	60.3
DMU03	Algeria	23.39	4.60	1.94	3.56	57.3
DMU04	Azerbaijan	6.53	23.40	2.39	16.60	65.2
DMU05	Bahrain	18.24	6.64	1.42	3.39	63.7
DMU06	Bangladesh	5.11	5.61	0.76	9.11	71.2
DMU07	Benin	9.45	4.22	0.74	1.26	72.1
DMU08	Brunei	25.57	0.38	2.50	0.30	66.8
DMU09	Burkina Faso	18.69	4.23	0.48	-0.25	83.3
DMU10	Cameroon	12.09	3.30	0.96	0.91	63.8
DMU11	Chad	30.61	0.65	2.05	-8.81	74.1
DMU12	Comoros	12.24	-1.11	0.32	4.49	73.1
DMU13	Cote d'Ivoire	22.57	1.64	1.08	1.91	62.5
DMU14	Djibouti	26.21	5.21	0.74	4.97	67.3
DMU15	Egypt	8.17	7.13	0.83	10.95	47.3
DMU16	Gabon	17.58	5.56	1.94	5.03	70.9
DMU17	Gambia	8.53	7.08	0.66	5.37	76.9
DMU18	Guinea	5.40	1.51	0.74	22.86	84.1
DMU19	Guinea-Bissau	17.00	2.52	0.73	4.62	71.4
DMU20	Guyana	18.67	5.35	0.80	12.20	65.6
DMU21	Indonesia	6.68	6.32	1.16	6.17	67.7
DMU22	Iran	10.34	5.84	1.21	18.40	53.3
DMU23	Iraq	14.81	2.77	1.49	n.a	41.8
DMU24	Jordan	15.10	5.80	0.62	5.39	44.4
DMU25	Kazakhstan	7.12	8.69	1.16	10.77	69.4
DMU26	Kuwait	12.29	4.58	2.06	5.47	66.9
DMU27	Kyrgyzstan	12.10	8.28	0.50	10.20	63.8
DMU28	Lebanon	4.52	4.01	0.50	4.06	50.1
DMU29	Libya	13.10	6.80	3.39	6.20	52.7
DMU30	Malaysia	14.49	6.35	1.23	2.03	62.7
DMU31	Maldives	29.27	6.67	1.01	7.40	65.5
DMU32	Mali	19.11	2.48	0.81	2.50	50.1
DMU33	Mauritania	20.06	0.88	0.84	7.26	70.1
DMU34	Morocco	18.26	2.20	0.79	2.04	51.4
DMU35	Mozambique	13.68	7.00	0.64	8.16	82.9
DMU36	Niger	12.77	3.13	0.56	0.06	62.5
DMU37	Nigeria	26.06	6.40	2.06	5.47	54.5
DMU38	Oman	30.16	6.41	1.43	5.89	55.2
DMU39	Pakistan	12.70	6.40	0.66	7.77	53.8
DMU40	Palestine	16.11	0.00	0.17	n.a	40.8
DMU41	Qatar	19.50	14.23	1.89	13.76	77.2
DMU42	Saudi Arabia	26.36	4.14	1.65	4.11	54.3
DMU43	Senegal	10.38	5.03	0.63	5.87	73.3
DMU44	Sierra Leone	16.87	6.82	0.47	11.65	66.1
DMU45	Somalia	9.96	2.68	0.18	n.a	71.1
DMU46	Sudan	13.72	10.52	0.81	7.98	51.5
DMU47	Suriname	4.67	5.53	0.87	6.43	51.1
DMU48	Syria	11.21	3.88	1.12	4.68	49.8
DMU49	Tajikistan	8.63	7.78	0.76	13.17	61.5
DMU50	Togo	10.53	2.07	0.58	0.96	68.9
DMU51	Tunisia	14.91	6.33	0.97	3.15	48.3
DMU52	Turkey	10.31	5.07	0.80	8.76	47.5
DMU53	Turkmenistan	13.36	11.61	1.16	6.26	64.8
DMU54	Uganda	9.26	6.49	0.33	6.80	85.9
DMU55	United Arab Emirates	10.55	7.67	1.39	11.13	77.7
DMU56	Uzbekistan	17.12	9.50	1.26	12.28	64.2
DMU57	Yemen	14.28	3.08	0.86	12.48	43.9
Data summary statistics	Mean :	14.72	5.59	1.05	6.65	62.7
	Standard deviation:	6.61	3.84	0.64	5.27	11.3
	Minimum :	4.52	-1.11	0.17	-8.81	40.8
	Maximum :	30.61	23.40	3.39	22.86	85.9

Notes:
*X*1: Final total government consumption expenditure (% of GDP); *Y*1: Growth rate of real GDP (%);
*Y*2: Balance of trade (=Value of export/Value of import) ; *Y*3: Rate of inflation (change in CPI, %)
*Y*4: Labour participation rate (ages 15 – 64 years, %).
Source: *Annual Economic Report on The OIC Countries,* 2008. Statistical, Economic and Social Research Training Centre for Islamic Countries (SESRIC).

Table 3 Technical efficiency results for OIC member countries, 2003-2007

DMU	Country	Model 1	Model 2	Model 3	$TE_{average}$
DMU01	Afghanistan	0.8109	0.7822	0.7064	0.7665
DMU02	Albania	0.9571	0.8567	0.6808	0.8315
DMU03	Algeria	0.8084	0.8021	0.8021	0.8042
DMU04	Azerbaijan	1.0000	1.0000	1.0000	1.0000
DMU05	Bahrain	0.8995	0.8616	0.7562	0.8391
DMU06	Bangladesh	1.0000	0.7923	0.7695	0.8539
DMU07	Benin	1.0000	0.8897	0.8145	0.9014
DMU08	Brunei	0.9966	0.9966	0.9966	0.9966
DMU09	Burkina Faso	1.0000	1.0000	1.0000	1.0000
DMU10	Cameroon	0.9750	0.8327	0.6788	0.8288
DMU11	Chad	1.0000	1.0000	1.0000	1.0000
DMU12	Comoros	0.8875	0.7993	0.7648	0.8172
DMU13	Cote d'Ivoire	0.7982	0.7596	0.5680	0.7086
DMU14	Djibouti	0.8109	0.8109	0.7192	0.7803
DMU15	Egypt	0.7711	0.6877	0.4904	0.6497
DMU16	Gabon	0.9715	0.9289	0.9286	0.9430
DMU17	Gambia	1.0000	0.9217	0.8641	0.9286
DMU18	Guinea	1.0000	1.0000	1.0000	1.0000
DMU19	Guinea-Bissau	0.8224	0.7935	0.7760	0.7973
DMU20	Guyana	0.6920	0.6920	0.6661	0.6834
DMU21	Indonesia	1.0000	0.8173	0.7596	0.8589
DMU22	Iran	0.5654	0.5439	0.5430	0.5508
DMU23	Iraq	…	…	…	…
DMU24	Jordan	0.8482	0.7865	0.5512	0.7286
DMU25	Kazakhstan	0.9300	0.8179	0.7813	0.8431
DMU26	Kuwait	0.9993	0.9011	0.9006	0.9337
DMU27	Kyrgyzstan	0.7901	0.7603	0.6876	0.7460
DMU28	Lebanon	1.0000	0.7724	0.4852	0.7525
DMU29	Libya	1.0000	1.0000	1.0000	1.0000
DMU30	Malaysia	0.9703	0.8876	0.7427	0.8669
DMU31	Maldives	0.7858	0.7859	0.7123	0.7613
DMU32	Mali	0.8293	0.7704	0.4297	0.6765
DMU33	Mauritania	0.7677	0.7677	0.7601	0.7652
DMU34	Morocco	0.8434	0.7736	0.4367	0.6845
DMU35	Mozambique	0.9769	0.9769	0.9763	0.9767
DMU36	Niger	0.9854	0.8508	0.6728	0.8363
DMU37	Nigeria	0.8458	0.8458	0.7490	0.8135
DMU38	Oman	0.7939	0.7939	0.6246	0.7374
DMU39	Pakistan	0.8134	0.7472	0.5366	0.6991
DMU40	Palestine	…	…	…	…
DMU41	Qatar	1.0000	1.0000	1.0000	1.0000
DMU42	Saudi Arabia	0.7785	0.7785	0.6493	0.7354
DMU43	Senegal	0.9066	0.8413	0.8074	0.8517
DMU44	Sierra Leone	0.7253	0.7253	0.6846	0.7118
DMU45	Somalia	…	…	…	…
DMU46	Sudan	0.8920	0.8560	0.7333	0.8271
DMU47	Suriname	1.0000	0.7557	0.5125	0.7561
DMU48	Syria	0.8855	0.7552	0.5016	0.7141
DMU49	Tajikistan	0.7210	0.6822	0.6309	0.6780
DMU50	Togo	0.9911	0.8232	0.7188	0.8443
DMU51	Tunisia	0.9319	0.8595	0.6648	0.8187
DMU52	Turkey	0.7699	0.6833	0.4336	0.6289
DMU53	Turkmenistan	0.9741	0.9301	0.8664	0.9235
DMU54	Uganda	1.0000	1.0000	1.0000	1.0000
DMU55	United Arab Emirates	1.0000	0.9589	0.9578	0.9722
DMU56	Uzbekistan	0.7615	0.7615	0.7179	0.7470
DMU57	Yemen	0.5846	0.5372	0.3472	0.4897
	Mean :	0.8864	0.8288	0.7325	0.8159
	Minimum :	0.5654	0.5372	0.3472	0.4897

Table 4 Sources of efficiency

DMUs	Weights	Normalized indicators	Actual contributions
DMU04 Azerbaijan	$\alpha_1 = 0.0436$ $\alpha_2 = 0.0160$ $\alpha_3 = 0.0385$ $\alpha_4 = 0.0581$	10.00 7.20 2.78 5.87	0.436 0.115 0.107 0.342 --- 1.000
DMU09 Burkina Faso	$\alpha_1 = 0.0000$ $\alpha_2 = 0.0000$ $\alpha_3 = 0.0496$ $\alpha_4 = 0.0658$	2.90 1.86 7.57 9.48	0.000 0.000 0.376 0.624 --- 1.000
DMU11 Chad	$\alpha_1 = 0.0000$ $\alpha_2 = 0.0666$ $\alpha_3 = 0.0582$ $\alpha_4 = 0.0000$	1.59 6.27 10.00 7.65	0.000 0.418 0.582 0.000 --- 1.000
DMU18 Guinea	$\alpha_1 = 0.0000$ $\alpha_2 = 0.0382$ $\alpha_3 = 0.0031$ $\alpha_4 = 0.0932$	1.92 2.60 1.00 9.64	0.000 0.099 0.003 0.898 --- 1.000
DMU29 Libya	$\alpha_1 = 0.0000$ $\alpha_2 = 0.1000$ $\alpha_3 = 0.0000$ $\alpha_4 = 0.0000$	3.88 10.00 5.73 3.37	0.000 1.000 0.000 0.000 --- 1.000
DMU41 Qatar	$\alpha_1 = 0.0436$ $\alpha_2 = 0.0161$ $\alpha_3 = 0.0385$ $\alpha_4 = 0.0581$	6.61 5.81 3.59 8.26	0.288 0.094 0.138 0.480 --- 1.000
DMU54 Uganda	$\alpha_1 = 0.0000$ $\alpha_2 = 0.0390$ $\alpha_3 = 0.0059$ $\alpha_4 = 0.0911$	3.77 1.45 5.56 10.00	0.000 0.056 0.033 0.911 --- 1.000

Table 5 Technical efficiency scores of OIC-FEC and OIC-MDC countries, 2003-2007

Rank	DMU	Country	*TE*	Peer DMUs	Group
1	DMU30	Malaysia	1.0000	[30]	MDC
2	DMU53	Turkmenistan	1.0000	[53]	FEC
3	DMU04	Azerbaijan	1.0000	[04]	FEC
3	DMU08	Brunei	1.0000	[08]	FEC
3	DMU16	Gabon	1.0000	[16]	FEC
6	DMU41	Qatar	1.0000	[41]	FEC
7	DMU10	Cameroon	1.0000	[10]	MDC
8	DMU29	Libya	1.0000	[29]	FEC
9	DMU55	United Arab Emirates	1.0000	[55]	FEC
10	DMU05	Bahrain	0.9948	[04,08,30,53]	FEC
11	DMU51	Tunisia	0.9651	[30, 53]	MDC
12	DMU02	Albania	0.9643	[30, 53]	MDC
13	DMU21	Indonesia	0.9509	[16, 30, 53]	MDC
14	DMU34	Morocco	0.9497	[08, 10]	MDC
15	DMU13	Cote d'Ivoire	0.9490	[08, 10]	MDC
16	DMU37	Nigeria	0.9442	[04, 29, 30]	FEC
17	DMU26	Kuwait	0.9421	[04,08,16,53]	FEC
18	DMU03	Algeria	0.9224	[10, 30]	FEC
19	DMU42	Saudi Arabia	0.9153	[08, 29, 30]	FEC
20	DMU38	Oman	0.8998	[04, 29, 30]	FEC
21	DMU25	Kazakhstan	0.8982	[16, 41, 53]	MDC
22	DMU28	Lebanon	0.8965	[10, 30]	MDC
23	DMU24	Jordan	0.8807	[30, 53]	MDC
24	DMU48	Syria	0.8759	[08, 10, 30]	MDC
25	DMU27	Kyrgyzstan	0.8472	[16, 41, 53]	MDC
26	DMU47	Suriname	0.8445	[30, 53]	MDC
27	DMU56	Uzbekistan	0.8255	[04,16,41,53]	MDC
28	DMU39	Pakistan	0.8251	[30, 53]	MDC
29	DMU20	Guyana	0.7845	[16, 41, 55]	MDC
30	DMU52	Turkey	0.7599	[30, 53]	MDC
31	DMU49	Tajikistan	0.7489	[16, 41, 55]	MDC
32	DMU15	Egypt	0.7437	[04, 30, 53]	MDC
33	DMU22	Iran	0.5452	[04,08,29,41]	FEC

Average: 0.9053 (All), 0.9403 (OIC-FEC), 0.8794 (OIC-MDC)

Table 6 Results for selected inefficient DMUs (2003-2007)

DMUs	Variable	Normalized value	Radial movement	Slack value	Normalized projected value	Projected value	Original value	Percentage change
DMU05	Y1	3.80	0.0197	0.00	3.8197	6.64	6.60	0.6
Bahrain	Y2	4.76	0.0247	0.00	4.7847	1.43	1.42	0.7
$\Omega_5 = 1.00519$	Y3	6.53	0.0339	0.00	6.5639	3.28	3.39	-3.4
$TE = 0.9948$	Y4	5.57	0.0289	0.00	5.5989	63.84	63.70	0.2
DMU51	Y1	3.69	0.1333	0.00	3.8233	6.65	6.30	5.6
Tunisia	Y2	3.23	0.1167	0.5818	3.9285	1.21	0.97	25
$\Omega_{51} = 1.03612$	Y3	6.60	0.2384	0.00	6.8384	2.32	3.15	-26
$TE = 0.9651$	Y4	2.50	0.0903	2.8083	5.3986	62.84	48.30	30