MEASURING EFFICIENCY IN BANKS: A BRIEF SURVEY ON NON–PARAMETRIC TECHNIQUE (DATA ENVIRONMENTAL ANALYSIS)

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ABSTRACT

Objective: This paper provides a survey of efficiency in banks using Data Envelopment Analysis (DEA) in developed and developing countries. Methods: There are two ways were used; the first one is analyse previous reviews, and the other one is systemic search from ProQuest, Emerald, Scopus and Science Direct. The search conducted to identify efficiency in banks in developed and developing countries. Originality: This study contributes in the existing literature in measuring efficiency in banks using DEA as a non–parametric technique. Results: Studies that was survey showed that the score of allocative efficiency was more than technical and cost efficiencies. Also, Studies showed that the scores of cost efficiency were more than the scores of profit efficiency. Conclusion: This paper shows that most of these studies were conducted in developed countries context, Also many studies were in developing countries. But, very few studies were conducted in the context of banking industry in Arab countries.

Keywords: Efficiency, Banks, Data envelopment analysis, Developed countries, Developing countries.

Contribution/ Originality

This study contributes to fill the gap in literature for studies were conducted to measure the efficiency of banking industry. Also it contributes in the body of knowledge by understanding the status of efficiency in the banking industry using non–parametric approach.

1. INTRODUCTION

Efficiency is a general term in economics that describes how well a system is performing in the generation of maximum outputs for a given input. Efficiency is improved if more outputs are generated without changing inputs or if the same outputs are generated with fewer inputs. The efficiency of the banking system is one of the most important issues in the financial market because the efficiency of banks can affect the stability of the banking industry and thus the effectiveness of the whole monetary system.

Bank efficiency ratio is a measure of a bank’s overhead as a percentage of its revenue. Bank efficiency is measured by different methods that estimate the frontier of production. These methods include non-parametric approach and parametric approach. In financial research, there is a huge body of literature that focuses on the efficiency of banking systems. This paper reviews Data Envelopment Analysis as a non-parametric and highlighted some empirical studies on bank efficiency that have been carried out in the past.
This study aimed to review the literature and find the gap on the literature in Arab Countries. The paper unfolds as follows section 2 provides types of efficiency. Section 3 provides a review on Data Envelopment Analysis, section 4 provides the methods for this study. And section 5 provides the results and discussion of this study.

2. TYPES OF EFFICIENCY

Efficiency is improved if more outputs are generated without changing inputs or if the same outputs are generated with fewer inputs. In today’s turbulent financial environment, efficiency of the banking industry is regarded as an important area in the financial market because it can not only affect the stability of the banking system but also influence the effectiveness of the whole monetary system. Bank efficiency can be measured by many types of efficiencies. Many types of different efficiencies are presented below:

2.1. Technical, Allocative and Cost Efficiency

According to Bauer et al. (1998) technical efficiency (or X-efficiency) focuses on the physical relationship of levels of inputs relative to levels of outputs, so it requires only the input and output data without the prices.

According to Thanassoulis (2003) the allocative efficiency of a firm is the ratio of the minimum cost at which a firm could secure its outputs to the cost of its technical efficient input levels for its input mix (for given input prices).

According Cummins and Zi (1996) the cost efficiency is the act of saving money by making a product or performing an activity in a better way.

Farrell (1957) has proposed a method of measuring productive efficiency, which uses an “efficient isoquant” estimated as part of the convex hull of the observed points. Farrell proposes an assumption under which the production function is homothetic. A homothetic function is a monotonic transformation of a homogeneous function in which the marginal rate of technical substitution is constant along a ray drawn from the origin. For instance, let a production function \( f(x_1, x_2) \) be homogeneous of the first degree in \( x_1 \) and \( x_2 \), and assume that the isoquant of this homogeneous production function is an efficient isoquant. An (increasing) monotonic transformation of a homogenous production function yields a homothetic production function in \( F(X) = g[f(x_1, x_2)] \) where \( g \) is a strictly increasing monotonic transformation. A series of homothetic isoquants can be derived from the original (efficient) isoquant by appropriate scaling up. In other words, a proportional increase or decrease of all inputs should not affect the marginal rate of technical substitution along the isoquants. A comparison between the efficient isoquant and any other isoquant for given output would indicate departure from full efficiency (Clemhout, 1968).

The analysis of efficiency carried out by Farrell (1957) can be best illustrated, for the single output and two inputs case in the unit isoquant diagram (Figure 1). Farrell (1957) initially assumes that constant returns to scale (CRS) depict the efficient production function or the frontier. The technological set is fully described by the unit isoquant YY’ that captures the combination of the inputs \( (X_1, X_2) \) by which the firm can produce a certain output when it is perfectly efficient. In the other words, YY’ shows minimum combinations of inputs needed to produce a unit of output. Thus, under this framework, every package of inputs along the unit isoquant is considered as technically efficient while any point above and to the right of it, such as point P, is defined as a technically inefficient producer since the input package that is being used is more than enough to produce a unit of output. Hence, the distance RP along the ray OP measures the technical inefficiency of a producer located at point P. This distance (RP) represents the amount by which all inputs can be reduced without decreasing the amount of output. Geometrically, the technical inefficiency level associated with package P can be expressed by the ratio \( RP/OP \) and, therefore, the technical efficiency (TE) of the producer under
analysis would be given by the ratio OR/OP, which takes a value between zero and one. A value of one implies that the firm is fully technically efficient.

**Allocative efficiency (AE)** involves the selection of an input mix that allocates factors to their highest value uses and introduces the opportunity cost of factor inputs to the measurement of productive efficiency. Allocative inefficiency can also be derived from the unit isoquant plotted in Figure (1) Given information on the market prices of inputs \((w_1, w_2)\), the isocost line CC through P is associated with \(w_1 x_1 + w_2 x_2 = k_1\) and the slope of this line reflect the input price ratio. However, this cost can be further reduced by moving this line in parallel fashion until it is tangential to the isoquant at Q.

The coordinates of CC then give \(w_1 x_1^* + w_2 x_2^* = k_0\) achieving the minimal cost at the prescribed output level. Now we note that we can similarly determine the relative distances of S and R to obtain the ratio OS/OR. With respect to the least cost combination of inputs given by the point Q, the above ratio indicates the cost reduction that a producer would be able to achieve if it moved from a technically but not allocatively efficient input package (R) to both a technically and allocatively efficient one (Q). Therefore, the allocative efficiency that characterises the producer at point P is given by the ratio OS/OR.

There is another measure that is commonly referred to as cost efficiency or economic efficiency. It can be represented by the ratio of minimal cost \((wx^*)\) to actual cost \((wx_0)\), that is, the ratio \(wx^*/wx_0 = OS/OP\). A cost efficient firm will choose its inputs and mixes according to their prices so as to minimize total cost. Cost inefficiency may arise from two different sources. One is deficiency in applying the technology (technical inefficiency) and another one is suboptimal allocation of resources (allocative inefficiency). Thus, total overall cost efficiency can be presented as the product of technical efficiency and allocative efficiency:

### 2.2. Pure Technical and Scale Efficiency

Scale efficiency of scale occurs when the company’s produces on the lowest point of its Long run average cost and therefore benefits fully from economies of scale (Sanchez, 2009). Also, scale efficiency measures a company’s productivity at a given point with respect to what it could accomplish if it operated at the most productive scale size, where the average productivity reach a maximum level (Kourentas and Tsekouras, 2007).

In Figure (2), the use of the unit isoquant assumes constant returns to scale (CRS), but this assumption does not always hold. A firm using more of both inputs than the combination represented by R may exhibit variable returns to scale (VRS). Thus, in general, technical efficiency can be further decomposed into measures of pure technical efficiency (PTE) and scale efficiency (SE). In Figure (2), assume the simple case of one input X and one output Y, P represents an existing bank. OA represents the constant returns to scale frontier. Firms can either lie on, or below the frontier, but cannot be above it. Therefore, the ratio of GR/GP represents the measure of technical efficiency of bank P which corresponds to OR/OP in Figure (2).

The concept of scale efficiency ascertains whether or not the firm operates at an optimum size. In order to measure scale efficiency, the assumption of variable returns to scale replaces that of constant returns to scale. In the above figure, FEBCD represents a variable returns to scale frontier. For the bank at point P, pure technical efficiency (PTE) equals the ratio of GE / GP. Scale efficiency is the ratio of GR / GE or equal to TE divided by PTE. The value of SE is unity when operating under constant returns to scale. Values of less than unity reflect scale inefficiency. Scale inefficiency could be caused by the firm having to operate under increasing returns to scale or decreasing returns to scale. In order to investigate this, the non-increasing returns to scale frontier is developed, represented by OBCD. If SE is not equal to unity and PTE is equal to GR/GP, decreasing returns to scale exists. If
PTE is not equal to GR/GP which is based on the frontier OBCD, then the scale inefficiency is due to increasing returns to scale.

3. DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis (DEA) can be defined as “a mathematical method using linear programming to measure the relative efficiency of a number of administrative units (decision-making units) through the identification of the optimal mix of inputs and outputs which are grouped based on their actual performance” Zhu (2003) and Manadhar and Tang (2002).

Also, Cullinane et al. (2006) define DEA as a non-parametric method of measuring the efficiency of a decision making unit with multiple inputs and outputs. And Jacobs (2001) defines DEA as the ratio of the weighted sum of outputs of a trust to its weighted sum of inputs (P. 106). Also efficiency is defined as the ratio of the actual quantity of output, relative to a maximal feasible quantity of output (Bryce, 1996).

“The relative efficiency of any decision-making unit (j0) for a group of decision-making units is calculated by solving the following fractional linear programming model” (Charnes et al., 1994):

Max \( u, v \)

\[ h_0 = \frac{\sum_{r=1}^{t} u_r Y_{rj0}}{\sum_{r=1}^{t} V_i X_{ij0}} \]

Subject to:

\[ \frac{\sum_{r=1}^{t} u_r Y_{rj}}{\sum_{r=1}^{t} V_i X_{ij}} \leq 1 \]

\[ j = 1, 2, \ldots, n \]

\[ U_r, V_i \geq 0 \text{ and } i \]

\[ (r = 1,2,3, \ldots, t), (i = 1,2,3, \ldots, m) \]

Where:

\( Y_{rj} = \) Quantity of the output of the unit

\( U_r = \) Weight allocated to the output

\( X_{ij} = \) Quantity of input to the unit

\( V_i = \) Weight allocated to the input

\( t = \) Number of outputs

\( m = \) Number of inputs

In DEA normally as logical operational sequencing, there are some units regarded as efficient and, in turn, some of these are considered non-efficient. As a result, these units constitute a set of units with the high efficiency units enveloping all inefficient units. In order to conduct a DEA, the data is divided into two parts; “the front or surface section” contains the efficient units and “the internal section” contains the non-efficient units.

The fractional formula in Equation (1) can be converted to a linear formula and can deal with the traditional linear programming problem by rewriting the objective function by the equality above by one, thus becoming the following form:

\[ \sum_{r=1}^{t} U_r Y_{rj0} \]

Subject to:

\[ \sum_{i=1}^{m} V_i X_{ij0} = 1 \]

\[ \sum_{r=1}^{t} U_r Y_{rj} \leq V_i X_{ij} \]

\[ j = 1, 2, 3, \ldots, n \]

\[ I = 1, 2, 3, \ldots, m \]

\[ -V_i \leq -\varepsilon \]

\[ -U_r \leq -\varepsilon \]

\[ r = 1, 2, 3, \ldots, t \]
To obtain the efficiency of decision-making units it is very important to repeat the earlier Primary Model of each unit and to shorten the time required to achieve the results. The Dual Model can be used and be indicated as follows (Cooper et al., 2003):

\[ \text{Min } \lambda Z_0 \]

Subject to:

\[ X_{ij_0} Z_0 \geq \sum_{j=1}^{n} i X_{ij_0} \quad i = 1, 2, 3, \ldots, m \]
\[ \sum_{i=1}^{n} j Y_{rj_0} \geq Y_{rj_0} \quad r = 1, 2, 3, \ldots, t \]
\[ \lambda_j \geq 0 \quad j = 1, 2, 3, \ldots, n \] (3)

The CCR (Charnes, Cooper, & Rhodes) model and the BCC (Banker, Charnes, & Cooper) model are the most significant DEA models. The CCR was the brainchild of Charnes et al. (1978). It evaluates efficiency and recognizes the source and level of inefficiency. The BCC model is credited to Banker, Charnes, and Cooper who based it on the CCR model. It provides an estimation of the technical efficiency based on the scale of operation in the unit required to render services to beneficiaries at the time of measurement, i.e., there is an association between efficiency and a specific operation size (Norman and Stoker, 1991).

3.1. CCR (Charnes, Cooper and Rhodes) Model

Charnes et al. (1978) introduced a measure of efficiency for each DMU that is obtained as the maximum of a ratio of weighted outputs to weighted inputs. So, the efficiency scores for DMUs are a function of the weights of inputs and outputs combinations, and they have to be less than or equal to unity.

Suppose that there are n DMUs to be assessed. Each DMU uses up varying quantities of m different inputs to attain s different outputs. For instance, DMUJ uses up amount \( x \) of input \( i \) and generates amount \( Y_r \) of output \( r \). The ratio of outputs to inputs provides the relative efficiency of the DMUJ = DMU0 to calculate the ratios of all the \( j = 1, 2, \ldots, n \) DMUs. The efficiency scores for DMU0 can be achieved by solving the following mathematical programming problem:

\[ \max h_0 (u, v) = U_r Y_{r0} / \sum_{i,j}^n X_{ij0} \]

Subject to

\[ \sum_{j=1}^{n} U_r Y_{rj} / \sum_{i,j}^n v_i x_{ij} \leq 1, \quad j = 1, 2, \ldots, n \] (5)
\[ U_r \geq 0, \quad r = 1, 2, \ldots, s \] (6)
\[ v_i \geq 0, \quad i = 1, 2, \ldots, m \] (7)

Where:
\( x_{ij} \) = the observed amount of input of the \( r \)th type of the \( j \)th DMU (\( x_i, > 0, i = 1, 2, \ldots, m \), \( j = 1, 2, \ldots, n \)).
\( Y_{rj} \) = the observed amount of output of the \( r \)th type for the \( j \)th DMU (\( Y_{rj} > 0, r = 1, 2, \ldots, s, j = 1, 2, \ldots, n \)).
\( U_r \) = the weight that determines output.
\( v_i \) = the weight that determines input.
\( r \) = indicates \( s \) different outputs.
\( i \) = denotes \( m \) different inputs.
\( j \) = indicates \( n \) different DMUs.

This problem produces an infinite number of solutions because if \((u^*, v^*)\) is optimal, then \((\alpha u^*, \alpha v^*)\) is optimal for positive \( \alpha \). Charnes and Cooper (1962) propose that for linear fractional programming a representative solution \((u, v)\) should be selected for which:

\[ v_i x_{i0} = 1 \] (8)

The transformed linear programming problem can be expressed as:
The linear programming dual problem can be expressed as:

\[
\max Z_0 = \sum U_r \ Y_{r0} \tag{9}
\]

Subject to

\[
\sum U_r \ Y_{rj} - \sum V_i \ X_i \leq 0 \quad j = 1, 2, \ldots, n \tag{10}
\]

\[
\sum V_i \ x_{i0} = 1 \tag{11}
\]

\[
U_r \geq 0, \quad r = 1, 2, \ldots, s \tag{12}
\]

\[
V_i \geq 0, \quad i = 1, 2, \ldots, m \tag{13}
\]

The linear programming dual problem can be expressed as:

\[
\min z_0 = \theta_0 \tag{14}
\]

Subject to:

\[
\sum \lambda_r \ Y_{rj} \geq Y_{r0} \quad r = 1, 2, \ldots, s \tag{15}
\]

\[
\theta_0 \ x_{i0} - \sum \lambda_j \ x_{ij} \geq 0, \quad i = 1, 2, \ldots, m \tag{16}
\]

\[
\lambda_j \geq 0, \quad j = 1, 2, \ldots, n \tag{17}
\]

Where:

\[
\theta_0 = \text{the technical efficiency of } DMU_0.
\]

\[
\lambda_j = \text{the weight of the } j\text{th DMU}.
\]

Both the primal and dual linear programming problems listed here yield an optimal solution for technical efficiency \(\theta\). The weight \(\lambda_j\) has a positive condition, so the problem obtains the CRS. Technical efficiency \(\theta\) should be less than or equal to one. Furthermore, for a DMU with technical efficiency, \(\theta_h < 1\) is considered as inefficient, and the efficiency \(\theta_j = 1\) shows the efficient DMU placed on the efficiency frontier.

3.2. BCC (Banker, Charnes and Cooper) Model

Banker, Charnes and Cooper used an alternative assumption of CCR model in their DEA model (BCC model) which is the variable return to scale (VRS), the constraints for the weights should be added \((X = 1)\). The DEA model in this case is called a BCC model that exhibits variable return to scale, and it can be written as:

\[
\min z_0 = \theta_0 \tag{18}
\]

Subject to:

\[
\sum \lambda_r \ Y_{rj} \geq Y_{r0}, \quad r = 1, 2, \ldots, s \tag{19}
\]

\[
\theta_0 \ x_{i0} - \sum \lambda_j \ x_{ij} \geq 0, \quad i = 1, 2, \ldots, m \tag{20}
\]

\[
\sum \lambda_j = 1 \tag{21}
\]

\[
\lambda_j \geq 0, \quad j = 1, 2, \ldots, n \tag{22}
\]

The use of this model will provide the BCC efficiency scores (referred to as pure technical efficiency scores) for each DMU. Under Constant Return to Scale, we assume that outputs vary in direct proportion to the variance in inputs no matter the DMU size. The CRS may prove unsuitable for a group of DMUs with a large scale of operations. The Variable Return to Scale presupposes that modifying inputs fails to produce any proportional change in outputs. This means that as a DMU is enlarged, its average cost either falls or rises. VRS envelops the data more closely than CRS, and consequently calculates technical efficiency scores greater than or equal to CRS. The VRS approach is more appropriate, because the sample consists of very small to very large banks. Also, The VRS approach allows banks to deviate from the CRS line (viewed as optimal scale operation) because of factors like imperfect competition, regulatory requirements, credit and Loan restrictions, macro-economic effects, etc. Another preference for the VRS approach over the CRS is that the more developed the banking system is, the more likely it is that the banks face non-constant returns to scale (McAllister and McManus, 1993; Wheelock and Wilson, 1999).
Constant return to scale assumption (CCR model) is only appropriate when the operation of all DMUs is at an optimal scale. However, if there is imperfect competition, a DMU may not function at optimal scale (Casu and Molyneux, 2003). While technical efficiency derived from VRS will be greater than or equal to that measured by using CRS because VRS envelops the data points more tightly than the CRS. The VRS has proven to be more popular recently and it gives an enhanced reflection of the authentic observations found in the real world.

4. METHODS

A systematic review was conducted to recognize all available study about non-parametric methods to evaluate the efficiency in banking industry. There are two ways were used; the first one is analyse previous reviews (Berger and Humphrey, 1997) and the other one is systemic search from ProQuest, Emiral, Scopus and Science Direct. The search conducted to identify efficiency in banks in developed and developing countries. The search using several combinations of keywords: Efficiency, Data envelopment Analysis, Banks, Developed Countries and Developing Countries. No restrictions on dates were utilized during online database searches, only studies that targeted measuring efficiency in banks using DEA were included, non-English articles, books, thesis, non-published material were excluded from this search. From the search we found many studies conducted in efficiency in banks using DEA in developed and developing countries. Also, from the search we chose some studies conducted in developed and developing countries that show in tables 1 and 2.

5. RESULTS AND DISCUSSION

The results show around 70 studies measuring efficiency using DEA conducted in developed and developing countries during period 1985 – 2014. These results divided in two tables. Table (1) shows empirical studies on measuring banking efficiency in banks using DEA in developed countries, and Table (2) shows empirical studies on measuring banking efficiency in banks using DEA in developing countries.

Table 1. Empirical Studies on Measuring Banking Efficiency in Banks Using DEA in Developed Countries

<table>
<thead>
<tr>
<th>Year</th>
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<th>Objective</th>
<th>Technique</th>
<th>Sample</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>Sherman and Gold</td>
<td>Aimed to measure and evaluate operating efficiency for a saving bank in USA</td>
<td>DEA</td>
<td>Saving bank branch with 14 branch offices in USA for one year period was chosen for this study.</td>
<td>They found that DEA results provide meaningful insights not available from other techniques that focus on ways to improve productivity. Also, they suggested that DEA is a beneficial complement to other techniques improving bank branch efficiency.</td>
</tr>
<tr>
<td>1993</td>
<td>Berg et al.</td>
<td>Attempted to measure the efficiency of banking in Sweden</td>
<td>DEA</td>
<td>Their sample was from three countries Finland, Norway, and Sweden, and the data set consists of observations from 50 Finnish, 150 Norwegian, and 1,06 Swedish banks in 1990.</td>
<td>They found that the average efficiency was 0.28 for Finland, 0.78 for Norway, and 0.80 for Sweden. The Norwegian average bank has around 10 percent higher productivity than the Finnish within both the VRS and CRS specifications, and the Swedish average bank is also more productive than the Norwegians, the productivity gap ranging from 40 to 60 percent.</td>
</tr>
<tr>
<td>1993</td>
<td>Suzuki</td>
<td>Aimed to measure technical and scale efficiency of Japanese commercial banks.</td>
<td>DEA</td>
<td>The headquarters of Japanese commercial banks that located in Tokyo and Osaka metropolitan areas, at the end of fiscal 1991 were chosen.</td>
<td>He found that his study showed that the major cause of overall technical inefficiency was pure technical inefficiency, not scale inefficiency. The scale inefficiency for pooled data was found to mainly due to increasing returns to scale. The study found it is possible to identify more outputs by making different inputs: outputs specifications and it is important to examine the effects of technological change.</td>
</tr>
<tr>
<td>1995</td>
<td>Elman and Mathias</td>
<td>Measure the technical efficiency of US banks pre and post deregulation periods</td>
<td>DEA</td>
<td>US banking data for years 1997 and 1998 which are pre and post deregulation periods</td>
<td>They found that technical efficiency declined for large banks. Also showed by using a time-dependent metric analysis that technology regressed over this eight-year span.</td>
</tr>
<tr>
<td>1995</td>
<td>Fevery and Paul</td>
<td>Aimed to provide a measure of technical and scale efficiency in the Indian banking industry by using Data Envelopment Analysis</td>
<td>DEA</td>
<td>174 Indian banks included in the Crimde Bank in 1991 were chosen for this study.</td>
<td>They found the technical efficiency and productive potential 53.6per cent and 78.1per cent, also they found the efficiency and size between 48per cent and 100per cent. These results were robust to modifications in the specification of inputs and outputs suggested by the intermediation approach and by Asset approach.</td>
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<td>A. M.</td>
<td>Aimed to trace efficiency of banks in US</td>
<td>DEA</td>
<td>Data from the Annual Reports and Accounts of 12 US banks from 1995 to 1997.</td>
<td>A high level of efficiency dispersion is observed. Smaller banks appear to achieve the highest levels of relative efficiency, thereby supporting the estimates of its dominance for scale of the most efficient banks.</td>
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<td>2006</td>
<td>Dickson and Nahm</td>
<td>Applied DEA to estimate the efficiency of producing revenue-generating banking services and the efficiency of producing profit in Australian banks.</td>
<td>DEA</td>
<td>They used a sample of 19 banks listed on the Australian Stock Exchange for the period of 1995 to 2002.</td>
<td>They found that the banking services and profit efficiency scores improved in the major banks because the banking service efficiency remained unchanged and the profit efficiency decreased for the regional banks. They also found that changes in profit efficiency were statistically significant in the major banks but not in the regional banks.</td>
</tr>
<tr>
<td>2006</td>
<td>Wu et al.</td>
<td>Integrated Data Envelopment Analysis (DEA) and neural networks (NNN) to examine the relative branch efficiency of a big Canadian bank.</td>
<td>DEA</td>
<td>They chose 142 branches in Toronto area from two big Canadian banks. The data were collected over 3 months from October to December in 2001.</td>
<td>This paper presented a DEA - NNN study to the efficiency in a big Canadian bank. The results were comparable to the normal DEA results on the share of the overall branch efficiency that was significantly higher for the models with technical efficiency than for the models with allocative efficiency.</td>
</tr>
<tr>
<td>2008</td>
<td>Kyi and Ikil</td>
<td>Aimed to assess the efficiency and scale efficiency of commercial banks in the Ukraine.</td>
<td>DEA</td>
<td>They chose the commercial banks in the Ukraine over the period from 1998 until 2003.</td>
<td>They found that efficiency scores are significantly correlated between the common and separate frontier results. Their results also showed that the average technical efficiency is only 5.0 percent and the dominant source of inefficiency is driven by poor management decisions (pure technical efficiency) rather than being any scale inefficiencies.</td>
</tr>
<tr>
<td>2008</td>
<td>Liu, and Torn</td>
<td>Prepared a three-stage method to measure DEA efficiency while controlling for the impacts of both statistical noise and environmental factors.</td>
<td>DEA</td>
<td>They chose the sample of data from branches from a Japanese bank for five years from 1997 to 2001.</td>
<td>They found a stable upward trend in measured efficiency, indicating that, on average, the bankers were learning over the sample period.</td>
</tr>
<tr>
<td>2008</td>
<td>Bruck and Shabroen</td>
<td>Aimed to address the issue of French banks efficiency, compared to their homologues from Europe and the United States.</td>
<td>DEA</td>
<td>The analysis is realized on a sample formed by the ten biggest banks from France, Germany, Italy, Spain, the United Kingdom and the United States over the periods 1994-2004.</td>
<td>The results show an improvement in cost efficiency of French and Spanish banks, while in the other countries a decline in cost efficiency is noted.</td>
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Table 2. Empirical Studies on Measuring Banking Efficiency in Banks Using DEA in Developing Countries

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<td>2009</td>
<td>Dobos et al.</td>
<td>Examined the technical and allocative efficiency of the Japanese banking sector.</td>
<td>DEA</td>
<td>They studied the Japanese banking system for eight years from 1995 to 2002, utilizing the slack-based measure.</td>
<td>Mean efficiency scores, the dispersion of efficiency scores, and the ranking of banks and bank sectors.</td>
</tr>
<tr>
<td>2010</td>
<td>Banker et al.</td>
<td>Wanted to study the impact of banking System reform during a crisis following a period of unfettered lending.</td>
<td>DEA</td>
<td>They present evidence documenting the differential impact of regulatory reforms on Korean commercial bank productivity.</td>
<td>The results showed that large banks are the most cost and profit efficient, supporting the concentration process observed in recent years. Foreign banks have achieved a good performance through both the establishment of new affiliates and the acquisition of local banks.</td>
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<td>2010</td>
<td>Teles and Tabak</td>
<td>Analyzed the cost and profit efficiency of the Brazilian banking sector.</td>
<td>DEA</td>
<td>Used Brazilian banking sector over the post liberalization period of 2000–2007.</td>
<td>These results suggest that banks are consistently higher on operating efficiency and risk than on the international and vintage cost-added approaches. On the other hand, banks are characterized by a relatively low level of cost.</td>
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<td>2011</td>
<td>Sasan</td>
<td>To critically examine the sources of inefficiency in the Korean banking sector.</td>
<td>DEA, and Value added approach</td>
<td>Used the annual bank level data of Korean commercial banks over the period 1992-2007.</td>
<td>The empirical findings suggest that estimates of TE are generally higher under an operating approach of TE than the intermediate and value-added approaches. On the other hand, banks are characterized by a relatively low level of cost.</td>
</tr>
<tr>
<td>2012</td>
<td>Barros et al.</td>
<td>Attempted to analyze technical efficiency of the Japanese banks.</td>
<td>DEA</td>
<td>They chose the Japanese banks from 2000 to 2007.</td>
<td>The results indicate that NRAs (non-performing loans) remain a significant barrier for banks’ performances.</td>
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<td>2001</td>
<td>Tariq and Rizwan</td>
<td>Aims to investigate input and output efficiency in the Turkish banking industry by using the impact of size, international variables, ownership, control and governance on profit, cost, allocative, technical, pure technical and scale efficiency measures</td>
<td>DEA</td>
<td>Turkish banks over the 1984–1996 periods were chosen for this study. The results suggested that the heterogeneity characteristics of banks have significant impact on their efficiency. Moreover, cost and profit efficiencies of the Turkish banks have deteriorated over time. Results also indicate that the dominant source of inefficiency in Turkish banking is due to technical inefficiency rather than allocative inefficiency, which is mainly attributed to differences in scale</td>
<td>Their data were collected for 68 Indian banks over the period 1996–1999. Almost all banks were overstaffed, with high wage payments and relatively low salaries.</td>
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<td>2002</td>
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<td>2003</td>
<td>Shortman and Das</td>
<td>Aims to analyze the efficiency performance of the Turkish banking sector</td>
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<td>For this study, they used 28 public sector commercial banks, 34 private sector commercial banks and 42 foreign banks in India as a sample. The study covered the period from 1988 to 1998. The mean efficiency score of Indian banks was 0.83 as per Model A and 0.63 as per Model B of the study. And it showed that the mean efficiency score of Indian banks compares well with the world mean efficiency score and the efficiency of private sector commercial banks as a group is, paradoxically lower than that of public sector banks and foreign banks in India.</td>
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<td>2004</td>
<td>Ataullah et al.</td>
<td>Provides a comparative analysis of the evolution of the efficiency of commercial banks in India and Pakistan</td>
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<td>They found that the overall technical efficiency of both Indian and Pakistan banks has improved greatly over the sample period.</td>
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<td>2005</td>
<td>Hassan et al.</td>
<td>Aims to investigate the relative efficiency of Islamic banking institutions in the world by analyzing a panel of banks</td>
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<td>31 Pakistani banks in 1998 and 2000 were chosen for this study. The results show that larger bank size and greater profitability are associated with higher efficiency.</td>
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<td>2009</td>
<td>Li et al.</td>
<td>Wanted to evaluate the operating performance of banks in a certain bank in Taiwan</td>
<td>DEA</td>
<td>The sample for this study was chosen from 127 branches of a certain bank in Taiwan in 2009. The average overall technical efficiency of branches is 43.44%.</td>
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<td>2009</td>
<td>Monga et al.</td>
<td>Aims to explore the impact of IT-based retail banking services on branch efficiency</td>
<td>DEA</td>
<td>They chose 165 full-service branches in Singapore’s metropolitan area. 17% of transactions at the branch level have a significant impact on efficiency, and there fore have a significant role to play in profit maximization</td>
<td>The results suggested that the decline in technical efficiency is more steep under the intermediation approach relative to the value-added approach and operating approach.</td>
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<td>2009</td>
<td>Sulian</td>
<td>This study investigated the first time the efficiency of Malaysian banking sector toward the Asian financial crisis</td>
<td>DEA</td>
<td>They used annual bank level and macroeconomic data of all Malaysian commercial banks over the period 1995–1996.</td>
<td>The overall technical inefficiency stems primarily from the managerial inefficiencies rather than scale inefficiency.</td>
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<td>2009</td>
<td>Alkhalid and Abdul Malik</td>
<td>They used basic DEA models (i.e., CCR and BCC) to evaluate the relative efficiency of Saudi Banks</td>
<td>DEA</td>
<td>They used annual data of Saudi banks from 2000 to 2008.</td>
<td>The results showed that, on a relative scale, Saudi banks were efficient in the management of their financial resources. In addition, the results would provide crucial information about Saudi banks’ financial conditions and management performance for the benefit of bank regulators, managers and bank stock investors.</td>
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<td>2010</td>
<td>Kumar and Gohel</td>
<td>The purpose of this paper is to appraise the problem of inefficiency and performance of 27 public sector banks (PSBs) operating in India by using a two-stage performance evaluation model.</td>
<td>DEA</td>
<td>Public sector banks in India over period 2006–2007 were chosen for this study.</td>
<td>The overall technical inefficiency stems primarily from the managerial inefficiency rather than scale inefficiency.</td>
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<td>2010</td>
<td>Teymo and Tahlik</td>
<td>Wanted to analyze the efficiency of the Brazilian banking sector.</td>
<td>DEA</td>
<td>The Brazilian banking sector over the post-privatization period of 2000–2007 was chosen for this study.</td>
<td>The results showed that the local banks are the most cost and profit efficient, supporting the concentration process observed in recent years. Foreign banks have achieved a good performance through the establishment of new affiliates and the acquisition of local banks.</td>
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References


Qureshi and Stuhler (2011). The purpose of this paper is to analyze comparative efficiency of banking system in Pakistan comprising of Islamic banks (IBs), conventional banks with Islamic banking division (IBD) and conventional banks (CB). *International Journal of Business, Economics and Management*, 3(5), 62-72.

Shyu and Chang (2012). "The findings based on bankwide scope and deposit amount suggest that a branch operating bulk wealth management service and loan business have higher efficiency values than those that operate wealth management services only." *International Journal of Business, Economics and Management*, 3(5), 73-80.


Abdulali, Kumannd, and Yuen (2014). "The results showed that the specialized banks exhibit higher mean technical efficiency relative to commercial and private banks. The results of efficiency determinants showed positive relationship between bank efficiency, ROA, size of operation, capital adequacy, government owned and government linked banks (government ownership)." *International Journal of Business, Economics and Management*, 3(5), 91-100.
The main aim of this paper is to highlight the existing body of literature on efficiency in banks. To achieve this objective several definitions of efficiency were explored. In addition, some other important issues regarding banking efficiency were identified. Survey of methods to assess efficiency were presented. Finally, the gaps of the study was identified and the proposed model of the study present.

In the previous mentioned studies we noted that most of the studies compared between allocative, technical, and cost efficiencies. And there are some studies compared the efficiency of banks between countries such as Sathye (2001) and Brack and Jimborean (2009). Also, some studies compared efficiency between types of banks such as Sathye (2001). The previous studies also showed that the score of allocative efficiency was more than technical and cost efficiencies.

Also, in the empirical studies in section 3, we noted that there are studies compared between cost efficiency and profit efficiency and showed that the scores of cost efficiency were more than the scores of profit efficiency such as Chu and Lim (1998); Isik and Hassan (2002); Chen et al. (2005) and Ariff and Can (2008). Also, there are studies compared between large, medium, and small banks such as Hassan et al. (2004) in Bahrain and Tecles and Tabak (2010) in Brazil, and they found that large banks were more efficient than medium and small banks. And there are some studies conducted to measure the cost efficiency of Islamic banks such as Hassan (2006); Shahooth et al. (2006); Mokhtar et al. (2008) and Qureshi and Shaikh (2012) and they found that the Islamic banks were more cost efficient while Hassan (2006) found that the Islamic banks were less cost efficient.

As a conclusion, from the above previous studies in developed and developing countries the gap in the literature has been determined as follows:

- Most of these studies were conducted in developed countries context. Also many studies were in developing countries.
- Very few studies were conducted in the context of banking industry in Arab countries.

REFERENCES


**BIBLIOGRAPHY**


Figure 1. Technical, Allocative and Cost Efficiency
Source: Cooper et al. (2007)

Figure 2. Pure Technical and Scale Efficiency
Source: Hassan et al. (2004)