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Egyptian Commercial Banks Performance Evaluation Using Data Envelopment Analysis

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Abstract: This paper employs Data Envelopment Analysis (DEA) method to compute the technical efficiency of individual commercial banks in Egypt over the period after revolution of January 25, 2011.The sample of commercial banks includes: state owned banks and private banks (domestic and foreign owned banks). Results indicate that over the study period. There were seven banks could not achieve DEA efficiency score of 1 in 2011, while there were only three banks in 2012, and six banks in 2013. The inefficient banks operated at incorrect scale, where the majority experienced decreasing returns to scale (DRS) in their operations. Peer group analysis was also conducted to compare banks that are inefficient with efficient banks which belonged to a reference set. Moreover, the study was identified input and output slacks of inefficient banks and suggested the efficient input and output targets for improvements.
Keywords: Commercial banks, Efficiency, DEA, Slacks, Egypt.

INRTODUCTION

Commercial banks are the most important financial institutions of any economy, where they mobilize the savings and thus play a vital role in enhancing the productive capacity of the economy. Commercial banks have to be efficient otherwise they will create maladjustments and impediments in the process of development in the economy. The efficiency of a commercial bank is usually measured in terms of minimization of inputs to produce a specific level of output or maximization of output at a given level of inputs. Because efficiency is a relative term; one can measure the bank efficiency in different years or efficiency of various banks in same year.

Commercial banks in Egypt perform the more traditional banking operations such as deposit taking, payment services, foreign exchange operations and marketing of securities and other financial products. They may be privately owned or state owned, but there is no difference between them in terms of their activities. The number of commercial banks operating in Egypt by the end of December 2013 was 40 banks (3683 branches); of which 3 were state owned banks, and 27 were private and joint venture banks. [1]

In the literature, there are many studies that tried to evaluate the banking sector performance. A large body of literature exists on banking efficiency in the USA, and the banking systems in the western and developed countries, while, the empirical evidence on the developing countries banking sectors is few, especially in Egypt. To date, studies by Omran [2], Reda, M. [3], and Sunil and Binsheng [4] are the most notable empirical researches performed to examine the efficiency of the Egyptian banking sector. This motivates the researcher to undertake this study to fill the gap and add to the existing literature. The study uses panel data of 15 commercial banks over the period (2011-2013) and employs one of the non-parametric approaches which is Data Envelopment Analysis (DEA) in order to estimate the technical efficiency of the Egyptian commercial banks. In addition to analyze the sources of inefficiency of these commercial banks. The results of this study would be helpful to policy makers as well as scholars and researchers in finance and banking.

There are many reasons for selecting the DEA method for measuring the bank efficiency rather than parametric ones, such as: DEA is simple and less affected by outliers and it does not require information about the distribution and the variance of the data. DEA is applicable to small samples, which is particularly relevant to this study. The application of DEA does not require the specification of a particular functional form for the production frontier. Moreover, it does not require assumption about the data, and can be used in a broader range of data.

The rest of paper is organized as follows. The review of the literature is presented in section 2. DEA Specification methodology is discussed in section 3. Data and specification of banks inputs and outputs are illustrated in section 4. Empirical findings and the sensitivity analysis are summarized and discussed in sections 5 and 6 respectively, while conclusion is drawn in Section 7.

LITERATURE REVIEW

In this section, the study reviews the most empirical studies that adopted DEA approach in order to measure the performance of banking sector and identify the inefficient banks in either developed and developing countries.

Elyasiani and Mehdian [5] evaluated the relationship between size and productive performance of 150 randomly chosen USA commercial banks in 1986. They employed four inputs namely: labor, capital, time and saving deposits and demand deposits, and four outputs namely: investment, commercial and industrial loans, real estate loans and other loans. Their results indicated that small banks achieved higher levels of technical efficiency than the large banks. Moreover, in the prederegulation environment small banks were more efficient than the large banks while in the deregulated environment small and large banks were equally efficient. On the other hand, Miller and Noulas [6] examined the technical efficiency of 201 large banks over the period (1984-1990).In their DEA analyses, commercial and industrial loans, consumer loans, real estate loans, investment, total interest income, and total non-interest income were considered as outputs. Inputs included, total transactions deposits, total non-transactions deposits, total interest expense, and total non-interest expense. Their results indicated that the mean bank technical inefficiency averages at the 5% level. Also, larger and more profitable banks seemed to have higher levels of technical efficiency. Similarly, Wheelock and Wilson [7] also examined the efficiency of USA banks from 1984 to 1993. They used three inputs: labor, physical capital, and purchased funds, and five outputs: real estate loans, commercial and industrial loans, consumer loans, all other loans, and total demand deposits. The major finding of their results indicated that the USA commercial banks experienced large decreases in both efficiency and productivity ratios between 1984 and 1993. They also concluded that the inefficiency increased in the same period due to the failure of banks to adopt technological improvements made by a few banks.

Sturm and Williams [8] measured the efficiency of Australian banking system to assess the impact of deregulation and entry of foreign banks in post deregulation period (1998-2001). The results showed that bank efficiency had increased in post deregulation period; however, the main source of efficiency improvement was technological change rather than technical efficiency. The study also found that foreign banks were more efficient than domestic banks.

Bonin et al. [9] investigated the impact of bank privatization on six relatively advanced countries, namely, Bulgaria, Czech Republic, Croatia, Hungry, Poland and Romania. The study confirmed that foreign Greenfield banks were most efficient and state owned banks were least efficient of all bank types in these six countries with respect to both cost and profit.

Katib and Mathews [10] investigated technical efficiency of the Malaysian banking sector during the period (1989-1995).The results indicated that technical inefficiency in Malaysian banking was due to scale inefficiency. They suggested that banks with more market power (measured by their ratio of deposits to market deposits) tended to exhibit higher technical efficiency. While, Matthews and Ismail [11] examined the technical efficiency and productivity of the Malaysian banking sector during the period (1994-2000). They found that the foreign banks had exhibited higher efficiency levels compared to their domestic bank counterparts. The results suggested that the efficient banks were characterized by size, but not profitability or loans quality. Sufian [12] examined the impact of the Asian financial crisis on the efficiency of the Malaysian banking sector. He employed the DEA method and focuses on three major approaches namely the intermediation, value added, and operating approaches. The empirical findings clearly bring forth the high degree of inefficiency in the Malaysian banking sector, particularly a year after the Asian financial crisis. The results suggested that the decline in technical efficiency was more abrupt under the intermediation approach relative to the value added and operating approaches. Moreover, Izah et.al [13] employed DEA Approach to estimate the overall, pure technical and scale efficiencies for Malaysian commercial banks during the period (2000-2006).The results suggested that domestic banks were relatively more efficient than foreign banks. The results also suggested that domestic banks' inefficiency were attributed to pure technical inefficiency rather than scale inefficiency. In contrast, foreign banks inefficiency were attributed to scale inefficiency rather than pure technical inefficiency. The study further examined whether the domestic and foreign banks were drawn from the same environment by performing series of parametric and non-parametric tests. The results from the parametric and non-parametric tests suggest that for the years 2000-2004, both domestic and foreign banks possessed the same technology whereas results for 2005 and 2006 suggest otherwise. This

implies that banks in recent years have had access to different and more efficient technology.

Sathye [14] determined the efficiency of Indian commercial banks using two DEA models with different combination of inputs and outputs. He found that public sector commercial banks were most efficient in one model and foreign banks in second model but private sector commercial banks were found to be the least efficient in both models. Similarly, Rammohan and Ray [15] found out the same result when they compared the revenue maximizing efficiency of banks in India in 1990's. Deposits and operating costs were taken as inputs while loans, investments and other income were taken as outputs. They found that public sector banks were significantly better than private sector banks on revenue maximization efficiency. However it was found that the difference in efficiency between public sector banks and foreign banks was not significant. In contrast, Ketkar et al. [16] found foreign banks operating in India to be the most efficient compared with public and private owned banks. Further, they found no improvement in the efficiency of Indian banks during the study period.

Das et al. [17] examined the efficiency of Indian banks by using DEA model. Four input measures: deposits and other borrowings, number of employees, fixed assets and equity, and three output measures: investments, performing loan assets and other non-interest fee based incomes were used in the analysis. They found that Indian banks did not exhibit much of a difference in terms of input or output oriented technical and cost efficiency. However, in terms of revenue and profit efficiencies prominent differences were seen. They also found that size and ownership of the bank, and listing on the stock exchange had a positive impact on the average profit and revenue efficiency scores. Kumar and Gulati[18] aimed to measure the extent of technical, pure technical, and scale efficiencies in 27 public sector banks operating in India in the year 2004. The empirical findings of study revealed that Public sector banks operated at 88.5%level of overall technical efficiency; which means inputs could be reduced by 11.5% without sacrificing output if all banks were efficient as 7 benchmark banks identified by DEA. Further, the contribution of scale inefficiency in overall technical inefficiency had been observed to be smaller than what been observed due to managerial inefficiency. The findings pertaining to returns to scale in Indian public sector banking industry highlight that the predominant form of scale inefficiency is decreasing returns to scale. Recently, Majid K.[19] aimed to examine the efficiency of Indian commercial banks during (2000-2010) by utilizing DEA and adopting intermediation approach. Based on the sample of 8 commercial banks, his findings revealed that the mean of technical efficiency was 0.995 in VRS model and 0.969 in CRR model. The results suggested that Bank of India and ICICI bank were more efficient as compare to other banks in India and result confirmed that selected Public Sector Banks are more efficient than Private sector during the study period in India.

Mercan et al. [20] examined the financial performance of Turkish Banking Sector for the period (1989 -1999) taking into consideration the modes of ownership (public, private and foreign) and assets size. They found that average financial performance of all the commercial banks kept on increasing until 1993 and after that it started to decrease. Foreign owned banks and private banks were found to have been more efficient than public owned banks in Turkey. The banks that were taken over by the government regulatory agency were observed to perform poorly. Similarly, Selcuk P., and Tubs Y.,[21] also aimed at measuring and evaluating the efficiency of commercial banks in Turkey using (DEA) and Malmquist Productivity Index (MPI) methodologies. They selected two outputs (total loans and noninterest income) and four inputs (number of employees, physical capital, non-deposit funds and total deposits) over two years 2003 and 2004. Using data for the year 2003, 16 of the 31banks have been calculated efficient under CRS while 23 of them efficient under VRS assumption, while, for the year 2004, 11 of the 31 banks were found to be efficient under CRS, while 16 of them efficient under VRS assumption.

Chansarn [22] aimed to examine the relative efficiency of Thai commercial banks during (2003-2006) by utilizing DEA. Based on the sample of 13 commercial banks, findings revealed that the efficiency of Thai commercial banks via operation approach was very high and stable while the efficiency via intermediation approach was moderately high and somewhat volatile. In terms of size, large, medium and small banks, in average, were efficient via operation approach with the average efficiencies of 100%. However, small banks were the most efficient banks via intermediation approach. In China, Li [23] investigated the scale efficiency and technology efficiency of 14 commercial banks. She concluded that most banks had low comparative efficiency. She also found that inefficient banks generally had input surplus. Rahman [24] examined the efficiency of Islamic and conventional banks in Bangladesh by using different parametric and non-parametric approaches over the study period of (2003-2008). His results showed that conventional and Islamic banks had been improving and converge to the highest level of efficiency. Findings also show that conventional banks were only slightly more efficient than Islamic banks.

Shahid et al. [25] investigated the efficiency of banking sector in Pakistan based on DEA by using the data gathered both from Islamic and conventional banks over the period (2005-2009). The findings indicated that the technical efficiency of conventional banks was better than the Islamic ones but about the cost and allocative efficiency, both groups showed a healthy competition. Muhammad et.al.[26] evaluated the efficiency of commercial banks operating in Pakistan for a period (2001-2008). Banks are divided into three groups: state owned banks, domestic private banks and foreign owned banks. They found the average technical efficiency is 0.82 indicating that banks could have saved 18% of inputs to produce the same level of output. Foreign banks were found to be the most efficient followed by state owned banks and private banks were found to be the least efficient. Further they found that pure technical efficiency contributed more towards technical efficiency and banks were facing serious scale problems. The mean pure technical efficiency was 0.91 and mean scale efficiency was 0.88 which gave a clear indication that diseconomies of scale did exist in Pakistani banking industry. Moreover, they found an increasing trend in pure technical efficiency whereas a declining trend in scale efficiency during the same period. In 2011, Bilal et al. [27] investigated the efficiency of 5 private Islamic banks and 5 private conventional banks of Pakistan for (2006-2008). Intermediation approach was applied for the specification of inputs and outputs. The findings suggested that scale inefficiency was dominated by the pure technical inefficiency effects in determining Islamic bank's technical inefficiency. It was concluded that Islamic banks were more efficient in operating at an optimum size though they were managerially not that much efficient. The opposite was valid for commercial banks. On the other hand, Qureshi et al. [28] analyzed comparative efficiency of banking system in Pakistan by considering the Islamic banks, conventional banks with Islamic banking division and conventional banks across (2003-2008).They used both ratio analysis and DEA approach. The results indicated that Islamic banks were more cost efficient and less revenue efficient. Considering their high growth rate, it was recommended that Islamic banks should be encouraged to reach the efficient frontier by reducing their wastes.

In 2007, Mostafa, M.[29] investigated the efficiency of top 85 Arab banks using DEA for the year 2005. He found that, eight banks as per the CCR Score and four banks as per BCC Score were positioned on the efficient frontier. His results further demonstrated that, Al-Rajhi Bank and National Commercial Bank were placed among the top ten Arab banks with a relative ranking of eight and ten respectively. For GCC region Srairi [30] examined the effects of financial liberalization on banking productivity growth over the period (1999-2007). Based on DEA. The results showed that during the deregulation period, banks in GCC region experienced a gain in productivity change attributed mainly to technical change rather than to an increase in efficiency. He also noted that conventional banks tended to outperform Islamic ones in most productivity measures. Mohamed [31] also adopted DEA approach to investigate cost efficiency levels of banks operating in Jordan, Egypt, Saudi Arabia and Bahrain over the period (1992-2000). The estimated cost efficiency is further decomposed into technical and allocative efficiency at both variable and constant return to scale. The cost efficiency estimated for the banks under study averaged 50% when the estimates are derived under CRS while the estimates averaged around 70% under VRS over the study period. The efficiency scores varied across banks based on their relative size and across their geographical locations. Based on the size, the largest banks were found to be relatively the most cost efficient. Geographically, the Saudi banks were the most efficient while the Jordanian banks were the least efficient.

AlKhathlan and Abdul Malik [32] used basic DEA models (CCR and BCR) to evaluate the relative efficiency of Saudi Banks using annual data from 2003 to 2008. 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. Similarly, Srairi [33] adopted DEA to compute five different measures of efficiency including cost, allocative, technical, pure and scale efficiencies of 11 local commercial banks of Saudi Arabia for the period of (1999-2007). He pointed out that the cost efficiency was below the world mean and during the period of liberalization between the years of 2003-2007, most efficiency scores slightly increased which meant that the banks were efficient to generate revenue. The results also showed that the dominant source of cost efficiency was due to allocative inefficiency rather than technical one.

Marie et al. [34] examined 18 banks in Dubai applying a parallel DEA to measure the operational profitability and quality in 2008 based on data collected from financial statements and randomly selected bank customers. They found no statistical difference between Islamic and commercial banks in the operational profitability, however, Islamic banks dominate the commercial ones in the operational quality. They also pointed out that operational quality in Islamic banks depended on the assurance, responsiveness and reliability factors. More recently, Al-Shammari M. et. al. [35] measured the relative efficiency of seven banks

listed on Bahrain Boursa under the commercial banks sub-sector over the period of 2008 to 2012 by employing DEA analysis. Results show that 4 banks out of 7 were technically inefficient under VRS, with an overall average score of 0.816 during years 2008 and 2009. During the period(2010-2012) there were 5 banks out of 7 technically inefficient under VRS, with an overall average score of 0.754.There results were consistent with other studies carried out in developing counties, which showed that technical inefficiency exists in the banking sector.

In Egypt, Omran [2] measured the financial and operating performance of 12 Egyptian banks that were fully or partially privatized from 1996 to 1999 and compared pre verses post privatization performance of these banks. The study revealed that in post privatization period, some profitability and liquidity ratios for privatized banks declined significantly but other performance measures were not significant at any level. Moreover, the results indicated that relative performance changes of privatized banks were better than those of mixed banks with majority state ownership but worse than those of private owned banks, state owned banks and banks with majority private ownership particularly in terms of profitability. The study further found that private banks and banks with majority private ownership were more profitable and efficient than state owned banks and banks with majority state ownership. While, Reda, M.[3] tried to assess the Egyptian commercial banks performance in terms of efficiency and productivity growth over the period (1995-2003) using DEA method to measure bank efficiency and Malmquist productivity index to assess productivity change. Results indicated that, over the study Egyptian commercial banks' technical inefficiency was 22%. Smaller banks were found to be least efficient. Moreover, most of Egyptian banks operated at incorrect scale, a large majority experienced increasing returns to scale (IRS) in their operations, implying that substantial gains could be obtained from altering scale via either internal growth or consolidation in the sector. In 2009, Sunil,S and Binsheng,Q.[3] examined the competitiveness and efficiency of Egyptian Banking sector following a series of key reforms since 1992 using advanced economic model such as DEA. Results of DEA showed that private banks were more profit efficient than government banks. In contrast, government banks were marginally more cost efficient than private banks. However, the differences in profit, cost and efficiency measures were no statistically significant, domestic banks were marginally more efficient than foreign banks

DEA METHEDOLOY

The study will employ DEA which is a multi-variable and non-parametric model for measuring the relative efficiency of a homogeneous set of decision making units (DMUs). The efficiency score for each DMU is equal to a ratio of weighted sum of multiple outputs to weighted sum of inputs, and is to be optimized as many times as the total number of DMUs. The efficiency scores are computed in the presence of multiple outputs and inputs simultaneously and the weights for inputs and outputs are not unique. The simple way to measure efficiency of DMU which has one input and one output is to determine the output-input ratio. The efficiency will increase as the output value gets larger and the input gets smaller.[36] However, in reality DUM is using multiple inputs to produce multiple output. Charnes, et al. (CCR) [37] proposed that DEA model as a linear programming efficiency model that could be used to measure efficiency that involves multiple inputs and output. The CCR model is also known as the constant return to scale model, and it identifies inefficient units regardless of their scale size. In the CCR models, both technical and scale inefficiency are present.

In the CCR model, the objective is to maximize the efficiency value of a test firm *j* from among a reference set of *s* firms, by selecting the optimal weights associated with input and output measures. The maximum efficiencies are constrained to 1. The formulation for j^{th} firm represented as follows:

$$\textit{Maximize} \quad E_j = \sum_{r=1}^{n} Z_r O_{rj} \Big/ \sum_{i=1}^{m} H_i U_{ij} \qquad (1)$$

$$\textit{Subject to} \quad E_j \leq 1 \qquad \forall\ j=1,2,.....15$$

$$Z_r, H_i \geq 0 \qquad \forall\ i=1,2,.....,m \quad r=1,2,.....,n$$

Where: Ej : refers to the efficiency score. J: is the DUM under study, U_{ij}: is the amount of input consumed by DUM_j to produce O_{rj} of output. Z, H: are weights assigned to each output and input.

Objective function (1) and constraints composed of fractions and need to be transformed into linear form so that the model can be solved using simple linear programming such as simplex. There are two types of model in a linear programming technique that can be used; namely, the output orientation and input orientation models.

In the output orientation model, objective function is given by:

$$\text{Maximize} \quad \sum_{r=1}^{n} Z_r O_{rj} \qquad (2)$$

$$\text{Subject to} \quad \sum_{r=1}^{n} Z_r O_{rj} - \sum_{i=1}^{m} H_i U_{ij} \leq 0 \quad \forall j=1,2,.....15$$

$$\sum_{i=1}^{m} H_i U_{ij} = 1$$

$$Z_r, H_i \geq 0$$

Model (2) is a linear equation. It constrains the weighted sum of inputs to unity and maximizes the weighted sum of outputs at the *j*th unit choosing appropriate values of Z_r and H_i

In the input orientation model, the objective function is:

$$\text{Minimize} \quad \sum_{i=1}^{m} H_i U_{ij} \qquad (3)$$

$$\text{Subject to} \quad \sum_{i=1}^{m} H_i U_{ij} - \sum_{r=1}^{n} Z_r O_{rj} \geq 0 \quad \forall j=1,2,.....15$$

$$\sum_{r=1}^{n} Z_r O_{rj} = 1$$

$$Z_r, H_i \geq 0$$

Model (3) is a linear equation. It constrains the weighted sum of outputs to unity and minimizes the weighted sum of inputs at the *j*th unit, choosing appropriate values of of Z_r and H_i

The input-orientated model emphasizes how to use minimum input resources to achieve a given level of output. At the same time, an output-oriented model focuses on using a given set of inputs to achieve the maximum possible output. The relative efficiency of the banks selected can be measured through either of these two models.

The current study enhances the analysis on relative efficiency scores and peer group analysis of the sample of Egyptian commercial banks by adopting DEA method under input oriented CRS hypothesis

DATA AND SPECIFICATION OF BANK INPUTS AND OUTPUTS

The current study includes 15 major commercial banks in Egypt. Based on the CBE classification Commercial banks defined as all those labelled commercial and investment banks. This is because although investment banks are registered to function as "investment" banks, in reality, they tend to perform the same tasks as those registered as commercial banks [1]. The selected banks are: National Bank of Egypt (NBE), Banque Misr (BM), Banque du Caire (BDC), Bank of Alexandria (BOA), Commercial International Bank (CIB), Credit Agricole Egypt (CAE), Al Baraka Bank of Egypt (BBE), Qatar National Bank Al-Ahli (QNB), Faisal Islamic Bank of Egypt (FIBE), Housing and Development Bank (HDB), Abu Dhabi Islamic Bank (ADIB), Arab African International Bank (AAIB), HSBC Bank Egypt (HSBC), Bank Audi (BA), and Societe Arabe Internationale de Banque (SAIB). The annual balance sheet and income statement uitilized were obtained from different annual reports of the selected banks for the period (2011-2013). All the data employed are at nominal price and expressed in Million Egyptian pounds.

Previous studies show that there is no consensus regarding the inputs and outputs that have to be used in the analysis of the efficiency of the activity of commercial banks. In general there are five approaches for defining inputs and outputs in the analysis of the efficiency of a bank namely: the intermediation approach; the production approach; the asset approach; the user cost; and the value added approach. The first three approaches are developed according to the functions banks fulfill. The production and the intermediation approaches are the best known ones and the most used in the quantification of bank efficiency.

In the production approach, banks are considered as deposit and loan producers and it is assumed that banks use inputs such as capital and labor to produce a number of deposits and loans. According to the intermediation approach, banks are considered the intermediaries that transfer the financial resources from surplus agents to the fund deficit ones. In this approach it is considered that the bank uses as inputs: deposits, other funds, equity and work, which they transform into outputs such as: loans and financial investments.

The current study adopts the production approach to quantify the efficiency of Egyptian commercial banks with restricted choice of variables. Accordingly, three **outputs** are selected; namely: Net loans (NL), Net profit after taxes (NP), Net interest income (NI), and three **inputs** are selected; namely: Total Deposit (TD), Overhead expenses (OE), Equity (EQ). Table (1) shows the input and output variables of 15 commercial banks over the period (2011-2013). Descriptive statistics of the efficiency measures are presented in table (2). The table shows that average bank had 49.14 billion Egyptian pounds in total deposits in year 2011, and increased to 58.9 and 68.6 billion Egyptian pounds in years 2012 and 2013 respectively. The average banks loans were 21.57, 23.25 and 24.74 billion Egyptian pounds in years 2011, 2012 and 2013 respectively, while the average bank's net interest income (which includes interest of bonds, certificates of deposits and other interests) raised from 1.27 billion Egyptian pounds in year 2011 to 1.68 and 1,98 billion Egyptian pounds in years 2012 and 2013 respectively.

Table-1 Data on performance of commercial banks in Egypt during the period (2011-2013)
(Figures in Million Egyptian Pounds)

2011	**TD**	**OE**	**EQ**	**NL**	**NP**	**NI**
NBE	216398.82	149.344	13103.14	87492.78	921.7	3815.05
BM	154474.76	232.7	7037.46	45352.03	515.38	2138.3
BDC	43598.52	13.439	2398.54	17413.2	44.937	2269.63
BOA	30781.12	325	37811.22	19381.56	66.271	327.592
CIB	71467.94	188.13	8712.12	41065.38	1614.33	2689.95
CAE	20303.78	54.65	2002.74	11471.61	306.63	869.28
BBE	12660.994	17.954	903.034	5964.157	100.1	66.431
QNB	51709.69	111.85	7376.95	35099.03	1489.61	2129.09
FIBE	25559.84	60.55	2169.08	2957.6	219.74	870.12
HDB	7542.23	30.39	2374.24	6428.26	154.91	364.76
ADIB	12040.431	192	567.509	1539.146	153.976	57.927
AAIB	32420.73	49.241	4547.614	20512.59	712.171	959.57
HSBC	42195.945	186	4,213	19440.05	1119.959	1814.177
BA	14334.46	291.49	1586.23	8818.73	168.976	650.003
SAIB	1608.04	2.34	219.96	667.5	20.87	52.73
2012	**TD**	**OE**	**EQ**	**NL**	**NP**	**NI**
NBE	312714.06	149.64	16980.1	106785.9	1595.78	5382.8
BM	162523.6	86.86	12299.67	43459.34	708.86	3971.69
BDC	49012.37	83.767	3640.19	21389.03	830.457	1465.69
BOA	30951.43	24.39	39019.92	19420.19	167.012	471.545
CIB	80443.98	168.38	10764.53	41877.18	2226.99	3913.63
CAE	22737.57	56.02	2326.02	12925.64	470.97	1019.15
BBE	14405.427	3.605	1028.506	6838.277	135.75	66.411
QNB	53661.25	120.8	8428.27	35885.37	1537.9	2622.68
FIBE	32357.73	75.02	2775.09	2846.59	649.59	1386.21
HDB	8143.47	34.93	2503.5	5569.78	372.26	577.53
ADIB	12970.85	128.97	624.76	391.381	310.462	61.181
AAIB	37616.279	51.534	5614.824	21495.85	907.697	1318.583
HSBC	47237.707	29.296	4399.891	19592.79	1418.839	2195.314
BA	16644.6	342.72	1789.2	9626.4	236.25	675.99
SAIB	2028.9	2.42	231.54	658.36	28.15	66.65
2013	**TD**	**OE**	**EQ**	**NL**	**NP**	**NI**
NBE	360188.99	153.89	23847.3	109386.9	1656.08	5150.57
BM	188833.82	900.72	14474.98	48733.43	1160.632	5588.38
BDC	55098.48	128.38	5524.63	26272.63	1249.15	2142.21
BOA	33209.44	18.694	42950.8	19384.04	181.843	511.731
CIB	98219.09	206.98	11959.71	41865.76	3006.38	5053.75
CAE	24484.86	56.99	2769.68	12021.4	628.55	1152.2
BBE	15557.86	4.254	1172.78	7864.01	166	71.723
QNB	68011.78	134.94	10009.52	38891.44	1777.54	3018.71
FIBE	37467.29	83.74	3448.56	4643.01	750.45	1508.26
HDB	8837.7	29.46	2643.83	5822.36	427.78	479.39
ADIB	14563.667	194.429	765.428	294.736	407.193	117.418
AAIB	49330.148	33.565	7051.856	24562.37	1058.26	1542.863
HSBC	52881.881	46.053	4594.659	19746.74	1797.48	2656.523
BA	20111	419.3	2100	10934	343.7	731.5
SAIB	2961.97	2.44	262.08	734.14	30.84	77.18

Source: Compiled from Commercial Banks Annual Reports and Sa.Investing.com

Table- 2 Descriptive Statistics of the Efficiency Measures (2011-2013)

2011	**TD**	**OE**	**EQ**	**NL**	**NP**	**NI**
Mean	49139.82	127.04	6334.88	21573.57	507.304	1271.64
Std. Dev.	59502.28	108.28	9415.53	23028.22	539.62	1139.83
Minimum	1068.04	2.34	219.96	667.5	20.87	52.73
Maximum	216398.8	325	37811.22	87492.78	1614.33	3815.05
2012	**TD**	**OE**	**EQ**	**NL**	**NP**	**NI**
Mean	58896.61	90.55	7495.07	23250.81	773.131	1679.67
Std. Dev.	80541.22	86.641	9980.86	27059.72	650.05	1632.62
Minimum	2028.9	2.42	231.54	391.38	28.15	61.18
Maximum	312714.06	342.72	39019.92	106785.9	2226.99	5382.8
2012	**TD**	**OE**	**EQ**	**NL**	**NP**	**NI**
Mean	68650.53	160.92	8905.05	24743.8	976.125	1986.83
Std. Dev.	93078.6	231.83	11373.74	28611.74	819.11	1925.02
Minimum	2961.97	2.44	262.08	294.736	30.84	71.723
Maximum	360188.99	900.72	42950.8	109386.9	3006.38	5588.38

Source: Computed using Table (1) data

EMPRICAL RESULTS

All computation was performed by using DEAFrontier software. The efficiency of commercial banks in Egypt was examined by applying the DEA approach for all banks for each year. Tables 3A, 3B, and 3C show the results of efficiency scores estimated according to DEA method under input oriented CRS hypothesis over the period (2011-2013). Scores of efficiency are obtained by calculating the average score for each bank. The average efficiency score over all the period is 0.927, while the average efficiency score for years 2011, 2012 and 2013 is 0.940, 0.958 and 0.882 respectively.

The evaluation of technical efficiency scores by banks over the considered period reveals that Banque du Caire (BDC), Housing and Development Bank(HDB), Credit Agricole Egypt(CAE), Qatar National Bank Al-Ahli(QNB), Arab African International Bank(AAIB), Al Baraka Bank of Egypt(BBE), Abu Dhabi Islamic Bank (ADIB)and Bank Audi (BA) have an stable tendency, while National Bank of Egypt (NBE), Banque Misr(BM), Bank of Alexandria(BOA), CIB, HSBC and Faisal Islamic Bank (FIBE) have unstable ones.

A more detailed analysis of efficiency degrees per banks groups (state owned and private) shows that on average public banks are less efficient (0.904) than private banks (0.935) over the study period of time. For each year in the testing period, there are almost half of the commercial banks operated at inefficient level in year 2011, this could be happened due to the economic and political instability after Jaunary25, revaluation that affected negatively on the banking sector performance especially the biggest ones such as: NBE, BM, BOA, CIB, HSBC and FIBE. In year 2012 the number of inefficient banks decreased to 3 only, while 12 of commercial banks in the study sample were able to pass the crisis and address the problems that happened in 2011. But due to some of the political and economic turmoil that occurred during year 2013, 6 banks could not achieve the relative efficiency compared with other banks in the sample.

Among the public banks, Banque de Caire (BDC) shows better performance and is the most efficient banks while Banque Misr (BM) has the lowest efficiency as compared to other public banks. Among private banks Arab African International Bank (AAIB) and Bank Audi (BA) are the most efficient banks and Societe Arabe Internationale de Banque (SAIB) has the lowest rank.

The efficiency scores from the analysis clearly indicate from selected banks, private banks more efficient with the highest efficient level as close to 1 in all the years. It is clearly shown that Egyptian financial market is dominated by private banks.

Tables 3A, 3B and 3C present also the efficiency peers of each bank, the relevant weight and the lambda value; therefore a virtual bank can be formed as a weighted combination of some efficient banks. For example, in year 2011, BM has as efficient peers namely: BDC and BBE; so the reference set of BM is {BDC, BBE} with weights {0.994, 4.703}. For BM the results of 0.994 and 4.703 indicate that the target of BM is to become 99.4% of BDC and 470.3% of BBE. In years 2012 and 2013 BM still inefficient and had as efficient peers HSBC and BBE in addition to NBE with different weights{1.52, 0.199, 0.115} in year 2012, while in year 2013 the reference banks of BM are BDC, BBE, HSBC and BA with weights { 0.023, 5.817, 0,078, 0,078} respectively.

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Table-3A Efficiency Scores and peers for year 2011

DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	Returns to Scale	Optimal Lambdas with Benchmarks		
1	NBE	0.99054	7.865	DRS	2.996 BDC	4.653 BBE	0.216 QNB
2	BM	0.94213	5.696	DRS	0.994 BDC	4.703 BBE	
3	BDC	1.00000	1.000	CRS	1.000 BDC		
4	BOA	0.73877	3.015	DRS	3.015 HDB		
5	CIB	0.96220	1.362	DRS	0.138 BDC	0.181 CAE	1.042 QNB
6	CAE	1.00000	1.000	CRS	1.000 CAE		
7	BBE	1.00000	1.000	CRS	1.000 BBE		
8	QNB	1.00000	1.000	CRS	1.000 FIBE		
9	FIBE	0.75462	0.392	IRS	0.252 BDC	0.140 QNB	0.001 ADIB
10	HDB	1.00000	1.000	CRS	1.000 HDB		
11	ADIB	1.00000	1.000	CRS	1.000 ADIB		
12	AAIB	1.00000	1.000	CRS	1.000 AAIB		
13	HSBC	0.99775	2.086	DRS	0.597 QNB	1.489 HDB	
14	BA	1.00000	1.000	CRS	1.000 BA		
15	SAIB	0.72508	0.024	IRS	0.010 BDC	0.014 QNB	0.001 AAIB
Mean		0.94074					

Table-3B Efficiency Scores and peers for year 2012

DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	Returns to Scale	Optimal Lambdas with Benchmarks			
1	NBE	1.00000	1.000	CRS	1.000 NBE			
2	BM	0.71968	1.834	DRS	0.115 NBE	0.199 BBE	1.520 HSBC	
3	BDC	1.00000	1.000	CRS	1.000 BDC			
4	BOA	1.00000	1.000	CRS	1.000 BOA			
5	CIB	0.97657	3.805	DRS	1.576 CAE	0.020 QNB	1.604 HDB	0.606 HSBC
6	CAE	1.00000	1.000	CRS	1.000 CAE			
7	BBE	1.00000	1.000	CRS	1.000 BBE			
8	QNB	1.00000	1.000	CRS	1.000 QNB			
9	FIBE	1.00000	1.000	CRS	1.000 FIBE			
10	HDB	1.00000	1.000	CRS	1.000 HDB			
11	ADIB	1.00000	1.000	CRS	1.000 ADIB			
12	AAIB	1.00000	1.000	CRS	1.000 AAIB			
13	HSBC	1.00000	1.000	CRS	1.000 HSBC			
14	BA	1.00000	1.000	CRS	1.000 BA			
15	SAIB	0.68379	0.040	IRS	0.005 CAE	0.003 QNB	0.010 HDB	0.022 HSBC
Mean		0.95866						

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Table-3C Efficiency Scores and peers for year 2013

DMU No.	DMU Name	Input-Oriented CRS Efficiency	Sum of lambdas	Returns to Scale	Optimal Lambdas with Benchmarks				
1	NBE	0.68537	13.864	DRS	0.019 BDC	13.84 BBE			
2	BM	0.51600	5.996	DRS	0.023 BDC	5.817BBE	0.078 HSBC	0.078 BA	
3	BDC	1.00000	1.000	CRS	1.000 BDC				
4	BOA	1.00000	1.000	CRS	1.000 BOA				
5	CIB	0.93506	2.300	DRS	0.003 BDC	0.407 QNB	0.816 DUM10	1.074 HSBC	
6	CAE	0.99555	0.632	IRS	0.001 BDC	0.253 BBE	0.161 DUM8	0.154 HSBC	0.064 DUM14
7	BBE	1.00000	1.000	CRS	1.000 BBE				
8	QNB	1.00000	1.000	CRS	1.000 QNB				
9	FIBE	0.58427	0.463	IRS	0.002 BDC	0.059 HDB	0.402 DUM13		
10	HDB	1.00000	1.000	CRS	1.000HDB				
11	ADIB	1.00000	1.000	CRS	1.000 ADIB				
12	AAIB	1.00000	1.000	CRS	1.000AAIB				
13	HSBC	1.00000	1.000	CRS	1.000 HSBC				
14	BA	1.00000	1.000	CRS	1.000 BA				
15	SAIB	0.52319	0.068	IRS	0.000 BDC	0.055 BBE	0.003 QNB	0.009 HSBC	0.001 BA
Mean		0.88262							

SENSITIVITY ANALYSIS

Sensitivity analysis results for inefficient banks are shown in Tables (4) and (5). In DEA analysis, if the DMU's all input and output slacks are equal to zero, then DMU is defined to be CRS efficient, otherwise; some input and/or output slacks differ from zero, then DMU is defined to be CRS inefficient and could improve its efficiency by either reducing its input levels or increasing its output levels.[38]

In order to uncover the reasons for poor banks performance, we compute for each bank the input and output slack variables, which reflect the improvements needed for an inefficient bank to become efficient. Tables (4) and (5) show the potential improvement for inefficient banks (NBE, BM, BOA, CIB, FIBB, HSBS, SAIB), (BN, CIB, SAIB) and (NBE, BM, CIB, CAE, FIBE, SAIB) in years 2011, 2012 and 2013 respectively whereas other banks are efficient and, therefore require no change in their inputs and outputs.

For example, in year 2011, the CRS efficiency score BM is 0.942, and its inputs slack of TD and OE are 51607.38 and 134.916 respectively, while its output slack of NI is 429.69 respectively; this means the efficiency of BM could be improved by decreasing TD from 154474.76 to 102867.35 million Egyptian pounds and OE from 232.7 to 97.78 million pounds or increasing NI from 2138.3 to 2576.99 million pounds; then BM would have a DEA efficiency score of 1. In year 2012, the efficiency of BM can be improved by decreasing TD by 51787.77 million Egyptian pounds or increasing NP by 1659.405 million pounds, while in year 2013, BM needed to decrease its inputs TD and OE by 91394.8 and 836.9 million pounds in order to have a DEA efficiency score of 1.

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Table-4 Slack for inefficient banks for years (2011-2013)

	DUM No.	DMU Name	Input Slacks			Output Slacks		
			TD	OE	EQ	NL	NP	NI
2011	1	NBE	15710.211		124.01			3753.137
	2	BM	51607.38	134.916	407.23			429.69
	4	BOA	8041.7	233.373	7158.46		400.791	772.179
	5	CIB	48727.7	59.792	329.337			
	9	FIBE	7331.348		532.24	6343.33		
	13	HSBC	95.135	93.38↑	3725.691↑	11085.41		
	15	SAIB	442.09		92.41		0.38	
2012	DUM No.	DMU Name	Input Slacks			Output Slacks		
			TD	OE	EQ	NL	NP	NI
	2	BM	51787.77		3447.892		1659.4	
	5	CIB	1885.03	3.95	252.244		1.91	
	15	SAIB	641.55				13.416	
2013	DUM No.	DMU Name	Input Slacks			Output Slacks		
			TD	OE	EQ	NL	NP	NI
	1	NBE	143721.5	92.502	7502.98		666.428	
	2	BM	91394.8	836.9	7005.84			
	5	CIB	6378.357	78.177	776.67			
	6	CAE	108.916		12.33			
	9	FIBE	15576.444	63.229	1433.69	3692.11		
	15	SAIB	1412.304					

Table-5 Input and output targets for inefficient banks for years (2011-2013)

	DUM No.	DMU Name	Efficient input target			Efficient output target		
			TD	OE	EQ	NL	NP	NI
2011	1	NBE	200688.60874	149.344	12979.13053	87492.78112	921.70001	7568.18760
	2	BM	102867.38129	97.78470	6630.23424	45352.03016	515.38	2567.99089
	4	BOA	22740.24129	91.62753	30652.76	19381.56003	467.06223	1099.77161
	5	CIB	63593.85913	128.33799	8382.78306	41065.37844	1614.32994	2689.94990
	9	FIBE	18228.49215	60.55	1636.84073	9300.93482	219.74	870.12
	13	HSBC	42100.81469	112.02279	7939.07862	30525.46038	1119.95901	1814.17703
	15	SAIB	1165.95157	2.34	127.55443	667.50001	21.25006	52.73
2012	DUM No.	DMU Name	Efficient input target			Efficient output target		
			TD	OE	EQ	NL	NP	NI
	2	BM	110735.83000	86.86	8851.77835	43459.33989	2368.26569	3971.68999
	5	CIB	78558.95281	164.43439	10512.28694	41877.17998	2228.90101	3913.62999
	15	SAIB	1387.35138	2.42	231.54	658.36	41.56683	66.65
2013	DUM No.	DMU Name	Efficient input target			Efficient output target		
			TD	OE	EQ	NL	NP	NI
	1	NBE	216467.49418	61.38809	16344.32858	109386.90115	2322.50882	5150.57011
	2	BM	97439.02093	63.82474	7469.14869	48733.42985	1160.632	5588.37990
	5	CIB	91840.73378	128.80328	11183.04534	41865.76044	3006.38004	5053.75006
	6	CAE	24375.94414	56.99	2757.35965	12021.40005	628.55	1152.2
	9	FIBE	21890.84689	20.51165	2014.87481	8335.12659	750.45	1508.26001
	15	SAIB	1549.66656	2.44	262.08	734.14	30.84	77.18

CONCLUSION AND RECOMMENDATATIONS

DEA method enables to estimate the technical efficiency of the selected Egyptian commercial banks during the period (2011-2013), where we have run tests for each year. The study results show that the January, 25 revolution affected the commercial banks performance via decreasing the growth rate of both selected inputs and outputs values which in turn reflected on banks efficiency scores. Using data for the year 2011, 7 of the 15 banks were technically inefficient under CRS assumption, with an overall average score of 0.940 (94%). In year 2012 the overall average score of efficiency raised to 0.958 (95.8%) where there were only 3 banks could not achieve DEA efficiency score of 1. The overall average score of efficiency declined to 0.882 (88.2%) in year 2013 and the number of inefficient banks raised to 6 banks. During these three years 3 of the 15 banks could not achieve DEA efficiency score of 1. The DEA provides useful information on inefficient banks to achieve efficiency by either decreasing inputs and/or increasing output where it provides slacks and targets of inputs and outputs for the technically inefficient banks as shown in tables (4-5).Finally, while Egypt have implemented many economic and financial reforms over the last decades, this might be appeared in the performance of the Egyptian banks during the study period. According to the study results, Egyptian banks would need to improve their technological orientation, to continue their efforts to reduce the percentage of non-performing assets and expand the possibilities for augmenting their financial activities in order to improve their profit efficiency in the near future.

The recommendations for future study, this paper could be extended in a variety ways. First, the scope of the paper could be extended to compare efficiency of commercial banks in Egypt with other commercial banks in Arab or MINA countries under CRS and VRS hypotheses. Secondly, the performance of commercial banks could be extended by considering the risk exposure factor. Thirdly, future research could investigate the changes in productivity of commercial banks over time due to technical changes or technological progress or regress by employing the Malmquist total factor productivity index.

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