# Efficiency and Determinants in Libyan Banking

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## Abstract

*This paper provides a comparative analysis regarding the performance of 17 Libyan banks over the period 2004 up to 2010. According to the relevant literature, there are few studies that combine both the Data Envelopment Analysis (DEA) technique and Tobit model for assessing the efficiency levels and subsequently examining the determinants of efficiency for the banking sector in Libya. For this study, the DEA technique was used to estimate technical, pure technical, and scale efficiency of sampled banks by using DEAP software. In the second stage, Tobit regression model was used to identify potential determinants of efficiency by using EViews 7 software. The results showed that the specialized banks have exhibited higher mean technical efficiency relative to commercial and private banks. The results of efficiency determinants showed positive relationship between bank efficiency, and ROA; size of operation; capital adequacy; and government linked banks (government ownership). This paper concludes with some policy implications of the results.*

**Keywords**: Efficiency, data envelopment analysis, specialized banks, commercial banks, private banks.

## *1. Introduction*

The financial industry usually plays an important role in the progress of a country and its economic development. In this regard, banks as financial intermediaries play a key role in transforming deposits into financial assets (Mohammed, 2002). The banking sector as one leading sector in modern economies has also become the criterion for measuring the safety of the national economy of any country (Berger & De Young, 1997). Nevertheless, technological innovation; deregulation of financial services sector; and international competition have affected the roles played by banks. More importantly, these changes have affected the performance of banks on the aspect of production efficiency.

Libya's banking system is dominated by four banks which are owned in full or have majority stake in them by Libyan Central Bank (Jamahiriya Bank, Wahda Bank, Sahara Bank, Umma Bank and the National Commercial Bank). These banks constitute almost ninety percent of Libya's banking sector assets. All of these banks have capital of at least 100 million Libyan Dinars (76.923 million USD), and two of them (Wahda Bank and Sahara Bank), were in the process of being privatized in 2006. In November 2007, five foreign banks were short listed for the privatization of Wahda Bank. These branches are France, Italy, Jordan, Bahrain and Morocco institutions. Arab Bank of Jordan was selected. They bid on a 19% of the share of Wahda Bank, with the option to increase their ownership to 51% in three to five years. France's BNP Paribas acquired 19% of Libya's Sahara Bank in July 2007, and took operational control of the bank. The deal also includes an option allowing BNP Paribas to purchase additional shares up to 51% of Sahara's capital over the next three to five years.

The availability of financing on the local market was weak. Libyan banks offer limited financial products, loans are often made on the basis of personal connections (rather than business plans), and public bank managers lack clear incentives to expand their portfolios. Clearly, there is lack of financial support that halts Libya's development. The Libyan banking system is currently undergoing a substantial modernization program to upgrade available services/products, deal with large numbers of nonperforming loans, establish a functioning national payments system, facilitate the use of non-cash payment instruments, and institute new standards of accounting and training. While foreign banks are technically able to enter the Libyan market under the Banking Law of 2005, the Central Bank has sought to delay their entry until the reform process is completed (Mireles et al., 2009).

The banking sector in Libya encountered large and very important changes with the installation of a new national payments system, a program which was implemented in 2005 following consultation with the World Bank (Panorama Report, 2008). This shows that previously the banking sector in Libya was a local, heavily regulated, and restricted business, resulting in a closed and uncompetitive bank sector. After 2003, the industry has embarked on a series of economic reforms to establish free market to be more competitive and open. With these reforms, interest and foreign exchange rates were freed, and new financial products and institutions were permitted. In addition to that, the mixed economy of the country, where all sizes and types of banks (commercial, private, and specialized) compete with each other, makes the Libyan banking industry a significant case for measuring the efficiency levels of the different types of banks. These banks face serious challenges in the face of liberalization. The banking system in Libya was affected by this challenging environment because, with banking liberalization, any inefficient banks will be forced out of the market by the more efficient banks. A review of the literature has revealed that very little effort have been made to determine the banking efficiency in developing countries (Hassan, Al-Sharkas, Samad, 2004). Therefore, it appears that there are no sufficient studies that have been conducted for Libyan banking.

For this reason, this paper provides a comparative analysis of the performance of banking sector in Libya over the period 2004 to 2010 by following a two stages approach: estimating efficiency scores in the first stage, and using Tobit regression model for identifying efficiency determinants in the second stage. The paper unfolds as follows. Section 2 provides an overview of the banking system in Libya, section 3 provides a review of the literature, and section 4 provides an overview of DEA and the types of efficiency measures, followed by section 5 on the methodology, data, and variables. Section 6 provides discussion on the results while section 7 is the conclusion.

## *2. Literature review*

In a rapidly changing financial market worldwide, bank regulators; managers; and investors are concerned about how efficiently banks transform their expensive inputs into various financial products and services. According to Berger, Forsund, Hjalmarsson, and Suominen (1993), although rapid changes in the financial services industry have been taking place all around the globe, the efficiency research has not kept pace with these changes. In their excellent international survey paper, Berger and Humphrey (1997) also focused their attention regarding the imbalance of the focus in the literature after reviewing 130 efficiency studies from 21 countries. They reported that the large majority of the studies on banking efficiency focus on the banks of developed countries.

Mostafa (2007) aimed to measure the relative efficiency of the top 100 Arab banks. The sensitivity of the results was also investigated. Top 100 Arab banks over the period 2005 – 2006 were chosen for this study. His results indicated that the performance of several banks was sub-optimal, suggesting the potential for significant improvements. Separate benchmarks were derived for possible reductions in resources used, and significant savings were possible on this account.

On Mokhtar, Abdullah and Al - Habashi (2008), this study aimed to empirically investigate the efficiency of the fully fledged Islamic banks and Islamic windows in Malaysia. The study used 288 panel data from the banks' financial statement of 20 Islamic Windows, 2 full-fledged Islamic banks and 20 conventional banks from 1997 to 2003. Their findings showed that, on average, the efficiency of the overall Islamic banking industry has increased during the period of study. The study also revealed that, although the fully fledged Islamic banks were more efficient than the Islamic windows, they were still less efficient than the conventional banks. Finally, Islamic windows of the foreign banks were found to be more efficient than Islamic windows of the domestic banks. Lin, Lee and Chiu (2009) evaluated the operating performance of business units of a certain bank in Taiwan. Their sample for this study was chosen from 117 branches of a certain bank in Taiwan in 2006.

Their results indicated that the overall technical efficiency of the case bank had many inefficient branches distinctly: the average overall technical efficiency of branches was 54.8% and the average pure technical efficiency of branches was 67%. The average scale efficiency was 82%. Resource wastage due to technical inefficiency was 45.2% while 55.3% was due to pure technical inefficiency.

Sufian (2009) investigated for the first time the efficiency of Malaysian banking sector around the Asian financial crisis 1997. They used annual bank level and macroeconomic data of all Malaysian commercial banks over the period 1995–1999. The results suggested that the decline in technical efficiency was more abrupt under the intermediation approach relative to the value added approach and operating approach.

Kumar and Gulati (2010) wanted to appraise the efficiency, effectiveness, and performance of 27 public sector banks (PSBs) operating in India by using a two-stage performance evaluation model. The public banks' sector in India over the period 2006-2007 was chosen for this study. The overall technical inefficiency stemmed primarily from managerial inefficiency rather than scale inefficiency. El Moussawi and Obeid (2011) aimed to propose a method of evaluating the productive performance of Islamic banks operating in the GCC. They chose the Islamic banks operating in the GCC region over the period 2005-2008. The technical inefficiency and allocation inefficiency increased bank costs, on average, by about 14% and 29%, respectively.

Sufian and Habibullah (2012) attempted to provide new empirical evidence on the efficiency of the Malaysian banking sector around the Asian financial crisis of 1997. Data of banks operating in Malaysia during the period 1995–2008 was used in this study. The results indicated that the foreign banks have exhibited higher technical efficiency compared to their domestic bank counterparts.

## *3. Research methodology*

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; Manadhar and Tang, 2002). The most important models of DEA are the CCR (Charnes, Cooper, and Rhodes) model and the BCC (Banker, Charnes, and Cooper) model. The CCR was developed by Charnes, Cooper, and Rhodes (1978). This model gives an evaluation of efficiency and identifies the source and amount of inefficiency. The BCC model is attributed to Banker, Charnes, and Cooper. This model is based on the CCR model and gives an estimate of the technical efficiency according to the scale of operation in the unit needed to provide services to beneficiaries at the time of measurement, i.e., the efficiency is associated with a certain size of operation (Norman & Stoker, 1991).

Technical efficiency concentrates 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 (Bauer, Berger, Ferrier, and Humphrey, 1997).
Based on the CCR and BCC scores, scale efficiency can be defined as follows:

Let the CCR and BCC scores of a DMU be $\theta^*_{CCR}$ and $\theta^*_{BCC}$ respectively. The scale efficiency (SE) is defined by

$$SE = \frac{\theta^*_{CCR}}{\theta^*_{BCC}} \qquad (5)$$

SE is not more than one. For a BCC-efficient DMU with CRS characteristics, i.e., in the most productive scale size, its scale efficiency is one. The CCR scores is called the technical efficiency (TE), since it takes no account of scale effect as featured from pure technical efficiency (PTE). On contrast BCC expresses the PTE under variable return to scale conditions. Using this information, relationship (5) shows a decomposition of efficiency as

$\theta^*_{CCR} = \theta^*_{BCC} \times$ SE, or

Technical eff. (TE) = Pure Technical eff. (PTE) × Scale eff. (SE) (6)

This decomposition, describes the sources of inefficiency, i.e., whether it is caused by inefficient operations (PTE) or by disadvantage conditions displayed by SE or by both (Cooper et al., 2007).

The sample for this study is 17 Libyan banks that comprise four commercial, five specialized banks that work in a specialized area such as agriculture, real estate, and foreign investments., and eight private banks, these banks are owned by people, whether they are normal or legal persons who take over the management of its affairs and will be responsible for all legal and financial activities of the bank.

This paper covers the period from 2004 to 2010. This span of time was chosen because the privatization of Libyan economy has started after United Nations and United States removed their sanctions on Libya in 2003, and 2011 was excluded because the revolution has started in Libya. In February 2011, the Libyan people revolted against Muammar Gaddafi's regime, which led to a war in Libya continued until the end of October 2011.This war has affected Libyan's economy. So, in this paper the year 2011 was excluded from this study as an exceptional year and the results that are obtained from the year 2011 will negatively affect on the full results of the study and may give an incorrect picture of the operations of Libyan banks, for this reason this paper covers the period from 2004 to 2010. The data were obtained from the Libyan central bank statistical bulletin, Libyan stock market, and annual reports from banks. Table I shows the types and the names of Libyan banks.

**Table1. Types of Libyan Banks**

| | **Commercial Banks** | **Specialized Banks** | **Private Banks** |
|---|---|---|---|
| 1 | Wahda Banks | Agriculture Bank | Commercial and Development Bank |
| 2 | Aljumhoria Bank | Real Estate Investment Bank | Mediterran Bank |
| 3 | Sahara Bank | Development Bank | Alsary Bank |
| 4 | National Commercial Bank | Libyan Foreign Bank | Alejmaa Alarabi Bank |
| 5 | | Alrefi Bank | United Bank |
| 6 | | | Amman Bank |
| 7 | | | Al Wafa Bank |
| 8 | | | Al Waha Bank |

### 3.1 Input and output definition

It is generally recognized that the selection of variables in efficiency studies significantly affects the results. Two approaches dominate the banking theory literature: the production and intermediation approaches (Sealey and Lindley, 1977).

The production approach views banks as primarily services producing for customers. The banks generate transactions and process documents for customers as an output, such as loans applications, credit reports, checks, or other payment instruments, while the input includes only the physical variables, such as the number of employees and the physical capital. The intermediation approach treats the work of banks as primarily intermediating funds between savers and investors (depositors and borrowers). The banks use operating and interest expenses to produce major assets. For instance, they use labour and capital as inputs to produce loans, investments, and other means of financing as outputs. Under the intermediation approach, a deposit is treated as an input.

To calculate the technical efficiency we are able to collect data on two outputs and three inputs namely: loan income (y1) (Drake, Hall, and Simper, 2009), profit after tax (y2) (Mostafa, 2007), No. of employees (x1) (Wu, Yang, Liang, 2006), total fixed assets (x2) (EL Moussawi and Obeid, 2011), and deposits (x3) (Sufian, 2007; Sufian, 2009; and Sufian, 2011). Variables y1, y2, x2, and x3 measured in millions of Libyan Dinar. And we are using DEAP software to analyze the data that are obtained of inputs and outputs.

### 3.2 Environmental variables

To further investigate the determinants of Libyan bank efficiency we follow a two-step approach, as suggested by Coelli et al. (1998). Using the efficiency measures derived from the DEA estimations as the dependent variable, we then estimate the following Tobit regression model using EViews 7 software:

$$TE = \beta_1 ROA + \beta_2 Risk + \beta_3 SO + \beta_4 LNDEPO + \beta_5 EQASS + \beta_6 GL + \beta_7 Mergers + \beta_8 OWS + \varepsilon_i$$

The determinants of the above model are elaborated below.

**3.2.1 Return on Assets (ROA)**

ROA is used to measure the profitability of banks. We expect a positive relationship with bank efficiency (Sufian, 2009). Our hypothesis is suggested below:

$H_0$ : Profitability is negatively related to bank efficiency, and

$H_a$ : Profitability is positively related to bank efficiency.

**3.2.2 Risk**

Our study also considered risk associated with capital structure as one of the factors that affect of the banking efficiency. Specifically, the level of capital measured by the ratio of equity capital to total assets, reflects the bank's management efficiency and risk preference (Kamaruddin, 2007).

$H_0$ : Large capitalized banks are less efficient and more risky, and

$H_a$ : Large capitalized banks are more efficient and less risky.

**3.2.3 Size of Operations (SO)**

It is used to measure the bank size to get the possible cost advantages associated with size (Sufian, 2009). We develop the following hypothesis in relation to size of operation and bank efficiency:

$H_0$: Large size is not positively related to efficiency, and

$H_a$ : Large size is positively related to efficiency.

**3.2.4 LNDEPO**

It is used as a proxy of market share" (Sufian, 2009). The hypothesis of market share is as follows:

$H_0$: Market share is negatively related to bank efficiency, and

$H_a$ : Market share is not negatively related to bank efficiency.

**3.2.5 EQASS**

t is the total book value of share holders equity over total assets, and it's used to measue a capital adequacy (Sufian, 2009). Our hypothesis as follows:

$H_0$: Capital adequacy is negatively related to bank efficiency, and

$H_a$ : Capital adequacy is positively related to bank efficiency.

**3.2.6 Government Link of bank and efficiency (GL)**

It is used to investigate the relationship between government ownership and efficiency (Sufian, 2009). We develop the following hypothsis in relation to Government Link of bank and efficiency:

$H_0$: Government Link of bank and efficiency is negatively related to bank efficiency, and

$H_a$ : Government Link of bank and efficiency is not negatively related to bank efficiency.

**3.2.7 Merger**

Ownership is expanded through mergers and acquisition. A merger can happen when to banks decide to combine into one or when one company buys another (Al-Khasawneh and Essaddam, 2012 ). The hypothesis of mergers is as follows:

$H_0$: Merger is negatively related to bank efficiency, and

$H_a$ : Merger is positively related to bank efficiency.

**3.2.8 Ownership Structure (OWS)**

In this paper we consider two ownership strucure: domestic structure and mixed structure ownership (domestic and foreign ownerships) in Libyan banks. This variable is used to measure the relationship between ownership of banks with efficiency. Our hypothesis is suggested below:

$H_0$: Mixed structure ownership is negatively related to bank efficiency, and

$H_a$ : Mixed structure ownership is positively related to bank efficiency.

Table 2 below contains information on the potential efficiency determinant variables.

**Table 2. Explanatory Variables and Measurements**

| Variable | Measurement |
|---|---|
| Return on Assets (ROA) | Net Income/ Total Assets |
| Risk | Equity Capital/ Total assets |
| Size of Operation (SO) | Natural Log of Total Assets |
| LNDEPO | Natural Log of Total Deposits |
| EQASS | Total book value of shareholders equity over total assets. |
| Government Link of bank and efficiency (GL) | Dummy variable that takes a value of 1 for government links banks, 0 otherwise. |
| Mergers | Dummy variable that takes a value of 1 for any banks mergers togther , 0 otherwise. |
| Ownership Structure (OWS) | Dummy variable that takes a value of 1 for foreign ownership ≥ 30%, 0 otherwise. |

## *4. Empirical results*

In this section, we will discuss the technical efficiency of Libyan banks, measured by the DEA method and its decomposition into PTE and SE components.

### 4.1 Efficiency of Libyan banks

Table 3 presents the mean efficiency score of the Libyan banks for the years 2004 (Panel A), 2005 (Panel B), 2006 (Panel C), 2007 (Panel D), 2008 (Panel E), 2009 (Panel F), 2010 (Panel G), and All years (Panel H).

The Libyan banks' mean technical efficiency has been on unstable, it increased during 2004 – 2005, then has been declining in 2006, after that has increased during 2007 – 2008 and has decreased in 2009, then has increasing again in 2010. It is clear from Table 3 that during the period of study, the Libyan banks have showed mean technical efficiency of 59.3 percent. The results suggest that the Libyan banks could have saved 40.7 percent of the inputs to produce the same amount of outputs that they produced. In other words, the Libyan banks could have produced the same amount of outputs by using only 59.3 percent of the amount of inputs used.

**Table 3. Summary Statistics of Efficiency Scores**

| Efficiency measures | Mean | Min | Max | SD |
|---|---|---|---|---|
| Panel A: All banks 2004 | | | | |
| Technical efficiency | 0.633833 | 0.015 | 1.000 | 0.371248 |
| Pure technical efficiency | 0.841833 | 0.188 | 1.000 | 0.241175 |
| Scale efficiency | 0.747333 | 0.021 | 1.000 | 0.345459 |
| Panel B: All banks 2005 | | | | |
| Technical efficiency | 0.686833 | 0.024 | 1.000 | 0.400416 |
| Pure technical efficiency | 0.857917 | 0.182 | 1.000 | 0.282044 |
| Scale efficiency | 0.78275 | 0.033 | 1.000 | 0.334787 |
| Panel C: All banks 2006 | | | | |
| Technical efficiency | 0.518917 | 0.034 | 1.000 | 0.401805 |
| Pure technical efficiency | 0.8635 | 0.064 | 1.000 | 0.275771 |
| Scale efficiency | 0.590333 | 0.084 | 1.000 | 0.364725 |
| Panel D: All banks 2007 | | | | |
| Technical efficiency | 0.541188 | 0.117 | 1.000 | 0.337561 |
| Pure technical efficiency | 0.780563 | 0.193 | 1.000 | 0.305176 |
| Scale efficiency | 0.73175 | 0.153 | 1.000 | 0.325762 |
| Panel E: All banks 2008 | | | | |
| Technical efficiency | 0.5545 | 0.016 | 1.000 | 0.372249 |
| Pure technical efficiency | 0.754938 | 0.218 | 1.000 | 0.307765 |
| Scale efficiency | 0.72075 | 0.039 | 1.000 | 0.332249 |
| Panel F: All banks 2009 | | | | |
| Technical efficiency | 0.520875 | 0.072 | 1.000 | 0.356196 |
| Pure technical efficiency | 0.74975 | 0.269 | 1.000 | 0.335373 |
| Scale efficiency | 0.7085 | 0.173 | 1.000 | 0.316195 |
| Panel G: All banks 2010 | | | | |
| Technical efficiency | 0.694625 | 0.161 | 1.000 | 0.304747 |
| Pure technical efficiency | 0.821 | 0.246 | 1.000 | 0.279753 |
| Scale efficiency | 0.842938 | 0.256 | 1.000 | 0.204832 |
| Panel H: All banks All years | | | | |
| Technical efficiency | 0.592967 | 0.015 | 1.000 | 0.363460 |
| Pure technical efficiency | 0.809929 | 0.064 | 1.000 | 0.289580 |
| Scale efficiency | 0.732051 | 0.021 | 1.000 | 0.317716 |

The decomposition of technical efficiency into its pure technical and scale efficiency components suggests that scale inefficiency dominates pure technical inefficiency of the Libyan banks during all years, except for the year 2010, when scale efficiency was higher compared to pure technical efficiency.

Table 4 presents the results of the commercial banks in Libya. It is clear that the commercial banks' efficiency was unstable, it was 90 percent in 2004 the declined in 2005 and increased again, after that decline again to reach to the least mean technical efficiency in 2007, then increased and declined after that increased again in 2010.

**Table 4. Summary Statistics of Efficiency Scores**

| Efficiency measures | Mean | Min | Max | SD |
|---|---|---|---|---|
| Panel A: Commercial banks 2004 | | | | |
| Technical efficiency | 0.9000 | 0.600 | 1.000 | 0.200 |
| Pure technical efficiency | 0.9065 | 0.626 | 1.000 | 0.187 |
| Scale efficiency | 0.9900 | 0.960 | 1.000 | 0.020 |
| Panel B: Commercial banks 2005 | | | | |
| Technical efficiency | 0.66250 | 0.262 | 1.000 | 0.393092 |
| Pure technical efficiency | 0.72275 | 0.391 | 1.000 | 0.323219 |
| Scale efficiency | 0.86125 | 0.669 | 1.000 | 0.166063 |
| Panel C: Commercial banks 2006 | | | | |
| Technical efficiency | 0.75400 | 0.298 | 1.000 | 0.331795 |
| Pure technical efficiency | 0.98525 | 0.941 | 1.000 | 0.029500 |
| Scale efficiency | 0.75875 | 0.317 | 1.000 | 0.323113 |
| Panel D: Commercial banks 2007 | | | | |
| Technical efficiency | 0.27175 | 0.184 | 0.408 | 0.105124 |
| Pure technical efficiency | 0.2775 | 0.193 | 0.415 | 0.104005 |
| Scale efficiency | 0.9755 | 0.953 | 0.999 | 0.019891 |
| Panel E: Commercial banks 2008 | | | | |
| Technical efficiency | 0.43675 | 0.204 | 0.987 | 0.372770 |
| Pure technical efficiency | 0.46500 | 0.217 | 1.000 | 0.369837 |
| Scale efficiency | 0.92625 | 0.816 | 0.987 | 0.076067 |
| Panel F: Commercial banks 2009 | | | | |
| Technical efficiency | 0.28025 | 0.177 | 0.390 | 0.087500 |
| Pure technical efficiency | 0.43925 | 0.182 | 1.000 | 0.377429 |
| Scale efficiency | 0.82425 | 0.390 | 0.991 | 0.290290 |
| Panel G: Commercial banks 2010 | | | | |
| Technical efficiency | 0.6690 | 0.581 | 0.784 | 0.087266 |
| Pure technical efficiency | 0.9025 | 0.740 | 1.000 | 0.124466 |
| Scale efficiency | 0.7490 | 0.628 | 0.901 | 0.120175 |
| Panel H: Commercial banks All years | | | | |
| Technical efficiency | 0.56829 | 0.177 | 1.000 | 0.225364 |
| Pure technical efficiency | 0.67125 | 0.182 | 1.000 | 0.216494 |
| Scale efficiency | 0.86929 | 0.317 | 1.000 | 0.145086 |

The results seem to suggest that the commercial banks have showed mean technical efficiency of 56.8 percent, suggesting that mean input waste was 43.2 percent. This implies that the commercial banks in Libya could have produced the same amount of outputs by only using 56.8 percent of the amount of inputs they employed. From Table 4 it is also clear that pure technical inefficiency outweighs scale inefficiency in determining the total technical efficiency of the commercial banks in Libya during the period of study.

We next discuss the specialized and private banks results in Tables 5 and 6 respectively. Similar to commercial banks' peers, the results from Table 5 seem suggest that the specialized banks in Libya have showed to increase during

**Table 5. Summary Statistics of Efficiency Scores**

| Efficiency measures | Mean | Min | Max | SD |
|---|---|---|---|---|
| Panel A: Specialized banks 2004 | | | | |
| Technical efficiency | 0.8368 | 0.456 | 1.000 | 0.243284 |
| Pure technical efficiency | 0.935 | 0.829 | 1.000 | 0.089208 |
| Scale efficiency | 0.8822 | 0.550 | 1.000 | 0.195216 |
| Panel B: Specialized banks 2005 | | | | |
| Technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Pure technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Scale efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Panel C: Specialized banks 2006 | | | | |
| Technical efficiency | 0.7608 | 0.341 | 1.000 | 0.330366 |
| Pure technical efficiency | 0.9110 | 0.632 | 1.000 | 0.159490 |
| Scale efficiency | 0.8204 | 0.370 | 1.000 | 0.277238 |
| Panel D: Specialized banks 2007 | | | | |
| Technical efficiency | 0.9848 | 0.924 | 1.000 | 0.033988 |
| Pure technical efficiency | 1.0000 | 1.000 | 1.000 | 0 |
| Scale efficiency | 0.9848 | 0.924 | 1.000 | 0.033988 |
| Panel E: Specialized banks 2008 | | | | |
| Technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Pure technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Scale efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Panel F: Specialized banks 2009 | | | | |
| Technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Pure technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Scale efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Panel G: Specialized banks 2010 | | | | |
| Technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Pure technical efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Scale efficiency | 1.000 | 1.000 | 1.000 | 0 |
| Panel H: Specailized banks All years | | | | |
| Technical efficiency | 0.9403 | 0.341 | 1.000 | 0.086805 |
| Pure technical efficiency | 0.9780 | 0.632 | 1.000 | 0.035528 |
| Scale efficiency | 0.9553 | 0.370 | 1.000 | 0.072349 |

2004 – 2005, then decline in 2006 after that they increased again during the period 2007 – 2010. The results seem to suggest that the specialized banks have showed mean technical efficiency of 94 percent, suggesting mean input waste 6 percent. This implies that the specialized banks in Libya could have produced the same amount of outputs by using 94 percent of the amount of inputs they employed.

**Table 6. Summary Statistics of Efficiency Scores**

| Efficiency measures | Mean | Min | Max | SD |
|---|---|---|---|---|
| Panel A: Private banks 2004 | | | | |
| Technical efficiency | 0.20550 | 0.015 | 0.378 | 0.152937 |
| Pure technical efficiency | 0.70025 | 0.188 | 1.000 | 0.359532 |
| Scale efficiency | 0.39925 | 0.021 | 0.906 | 0.370505 |
| Panel B: Private banks 2005 | | | | |
| Technical efficiency | 0.245 | 0.024 | 0.482 | 0.196465 |
| Pure technical efficiency | 0.726 | 0.182 | 1.000 | 0.385618 |
| Scale efficiency | 0.431 | 0.033 | 0.899 | 0.362707 |
| Panel C: Private banks 2006 | | | | |
| Technical efficiency | 0.10175 | 0.034 | 0.250 | 0.101359 |
| Pure technical efficiency | 0.71650 | 0.064 | 1.000 | 0.444901 |
| Scale efficiency | 0.23675 | 0.084 | 0.529 | 0.209961 |
| Panel D: Private banks 2007 | | | | |
| Technical efficiency | 0.355250 | 0.117 | 0.651 | 0.185562 |
| Pure technical efficiency | 0.822500 | 0.313 | 1.000 | 0.248798 |
| Scale efficiency | 0.481125 | 0.153 | 0.899 | 0.288102 |
| Panel E: Private banks 2008 | | | | |
| Technical efficiency | 0.29175 | 0.016 | 0.523 | 0.160769 |
| Pure technical efficiency | 0.67950 | 0.328 | 1.000 | 0.297073 |
| Scale efficiency | 0.47375 | 0.039 | 0.918 | 0.304787 |
| Panel F: Private banks 2009 | | | | |
| Technical efficiency | 0.298750 | 0.072 | 0.702 | 0.179001 |
| Pure technical efficiency | 0.677625 | 0.277 | 1.000 | 0.346765 |
| Scale efficiency | 0.501875 | 0.173 | 0.824 | 0.266843 |
| Panel G: Private banks 2010 | | | | |
| Technical efficiency | 0.508250 | 0.161 | 1.000 | 0.299493 |
| Pure technical efficiency | 0.690750 | 0.264 | 1.000 | 0.345790 |
| Scale efficiency | 0.764875 | 0.256 | 1.000 | 0.246351 |
| Panel H: Private banks All years | | | | |
| Technical efficiency | 0.286607 | 0.015 | 1.000 | 0.182227 |
| Pure technical efficiency | 0.716161 | 0.064 | 1.000 | 0.346925 |
| Scale efficiency | 0.469804 | 0.021 | 1.000 | 0.292751 |

From Table 6 it is also clear that scale inefficiency outweighs pure technical inefficiency in determining the total technical efficiency of the specialized banks in Libya during the period of study.

Table 6 seems to suggest that the private banks in Libya have showed unstable during the period of study. During the years, the private banks in Libya have showed a least mean technical efficiency of 29 percent (commercial banks 57 percent and specialized banks 94 percent). It is also clear from Table 6 that scale inefficiency outweighs pure technical efficiency in determining the total technical inefficiency of the private banks in Libya.

### 4.2 Determinants of Libyan Banks' Efficiency

In addition to estimating the DEA efficiency scores in stage one; we constructed an econometric regression model based on the efficiency scores as dependent variable to detect the relationship between efficiency and some of determinants. We estimated our model using Tobit regression onto a vector of explanatory variables in order to explain the variation in the efficiency scores obtained from stage one.

Table 7 used Tobit regression to give the estimated results during 2004 – 2010. The second column of this table revealed estimated coefficients and standard errors from Tobit regression for regression Technical efficiency change on the vector of explanatory variables. We examine the effect of factors on technical efficiency scores as in the following model:

$$TE = \beta_1 ROA + \beta_2 Risk + \beta_3 SO + \beta_4 LNDEPO + \beta_5 EQASS + \beta_6 GL + \beta_7 Mergers + \beta_8 QWS + \varepsilon_i$$

**Table 7. Determinants of Technical Efficiency**

| | TE |
|---|---|
| C | -1.134543 |
| ROA | 5.285418<br>(0.0490) |
| RISK | -0.308025<br>(0.8412) |
| SO | 0.125485<br>(0.1209) |
| LNDEPO | -0.055887<br>(0.4124) |
| EQASS | 0.673216<br>(0.6624) |
| GL | 0.459264<br>(0.0005) |
| MERGERS | -0.441623<br>(0.0084) |
| OWS | -0.399758<br>(0.0007) |
| R-squared | 0.554982 |
| Adjusted R-squared | 0.552049 |

In Table 7, according to Asteriou and Hall (2007) the fixed effects method relating to regression is used because Adjusted R-squared > 0.05. From table VIII, we find that ROA and GL are positive significant, while mergers, and OWS are negative significant related to technical efficiency at 5 percent confidence level. So, based on these findings we reject the null hypothesis and we accept the alternative hypothesis for ROA and GL and we accept the null hypothesis for mergers and OWS. ROA has coefficient estimate of 0.0490 this suggest that 0.0490 percent change in the ROA will increase technical efficiency by 1 percent. Also, GL has coefficient estimate 0.459264 this suggest that 0.459264 percent change in GL will increase technical efficiency by 1 percent. In contrast, mergers has negative coefficient estimate of -0.441623 that means 0.441623 percent decrease in mergers will increase technical efficiency by 1 percent. in the same way 0.399758 percent decrease in OWS will increase technical efficiency by 1 percent.

**Table 8. Determinants of Pure Technical Efficiency**

| | PTE |
|---|---|
| C | 2.327771 |
| ROA | 0.636409<br>(0.8805) |
| RISK | -0.179479<br>(0.9474) |
| SO | 0.041744<br>(0.7326) |
| LNDEPO | -0.118882<br>(0.2265) |
| EQASS | 0.448519<br>(0.8674) |
| GL | 0.472298<br>(0.0289) |
| MERGERS | -0.116519<br>(0.6664) |
| OWS | -0.452489<br>(0.0035) |
| R-squared | 0.327296 |
| Adjusted R-squared | 0.322224 |

From Table 8, GL is a positive significant, while OWS is a negative significant related to pure technical efficiency at 5 percent confidence level.

So, we accept the alternative hypothesis for GL, and we accept the null hypothesis for OWS. GL has coefficient estimate of 0.472298 this suggest that 0.472298 percent change in the GL will increase pure technical efficiency by 1 percent. In contrast, OWS has a negative coefficient estimate of -0.452489 that means 0.452489 percent decrease in OWS will increase pure technical efficiency by 1 percent.

**Table 9. Determinants of Scale Efficiency**

| | SE |
|---|---|
| C | -2.028563 |
| ROA | 7.252224<br>(0.0000) |
| RISK | -1.320891<br>(0.2415) |
| SO | 0.119942<br>(0.0539) |
| LNDEPO | 0.004585<br>(0.9303) |
| EQASS | 1.499859<br>(0.1923) |
| GL | 0.287483<br>(0.0132) |
| MERGERS | -0.431192<br>(0.0006) |
| OWS | -0.171071<br>(0.0717) |
| R-squared | 0.597292 |
| Adjusted R-squared | 0.594256 |

Based on Table 9, ROA and GL are positive significant, while Merger is a negative significant related to scale efficiency at 5 percent confidence level. Based on these results, we reject the null hypothesis, and we accept the alternative hypothesis for ROA and GL. On the other hand, we accept the null hypothesis for mergers. ROA has coefficient estimate of 7. 252224 suggesting that 7.252224 percent change in the ROA will increase scale efficiency by 1 percent. Also, GL has coefficient estimate 0.287483 this suggest that 0.287483 percent change in GL will increase scale efficiency by 1 percent. In contrast, mergers has negative coefficient estimate of -0.431192 that means 0.431192 percent decrease in mergers will increase scale efficiency by 1 percent.

According to the profitability ratios (ROA and ROE), the results suggested that the ROA was positively related to bank efficiency, and the coefficient had a positive statistically significant relation to the technical efficiency score at a 5% level. This result is consistent with the findings of Casu and Molyneux (2003). Also the findings about profitability indicate that the more profitable banks tend to exhibit lower inefficiency, which corroborates similar findings of some previous studies (Isik and Hassan, 2002; Hasan and Marton, 2003; Miller and Noulas, 1996)**.** Banks reporting higher profitability ratios are usually preferred by clients and therefore attract the biggest share of deposits as well as the best potential creditworthy borrowers. Such conditions create a favourable environment for the profitable banks to be more efficient from the point of view of intermediation activities.

In this paper the relationship between government linked banks and efficiency (GL) is positive related to technical efficiency and significant of the regression model. However, Sufian (2009) estimated the government linked banks and efficiency and he suggested that estimated coefficients entered the regression models with a negative sign, but are never significant in any of the regression models. The OWS is negative coefficient related to technical efficiency and significant of the regression model. In contrast, Sufian (2009) estimated the ownership structure in Malaysian banks and he imply that the regression model positively and is statistically significant in the value added approach regression models. Most of his findings showed that the banks with controlling share of foreign ownership are likely to be more efficient compared to their domestically owned counterparts.

## *5. Conclusion and policy implications*

In this paper, we examined the efficiency of the Libyan banks during the period 2004-2010. The efficiency estimates of individual banks were evaluated by using the non-parametric DEA approach.

The empirical findings suggest that during the period of study, pure technical inefficiency outweighs scale inefficiency in the Libyan banking sector, implying that the private and some of commercial banks have been managerially inefficient in exploiting their resources to optimal levels. The empirical findings seem to suggest that the specialized banks have exhibited higher technical efficiency compared to commercial banks and private banks. During the period of study we found that pure technical inefficiency has greater influence in determining the total technical inefficiency of commercial banks, while scale inefficiency has greater influence in determining the technical inefficiency of private and specialized banks.

The findings suggest that technical efficiency is positively and significantly associated with return on assets, and government linked banks with efficiency, also technical efficiency is negatively and significantly associated with merger and ownership structure. In future, this paper can be extended as follows. First, the scope of this study can be extended to investigate changes in cost, allocative, and technical efficiencies over time. Second, future studies could also examine the production function to compare with the intermediation function. Finally, future studies should capture changes in productivity over time as a result of technical change, technological progress, or regression by using the Malmquist Total Factor Productivity Index. Despite these limitations, the findings of this study are expected to extend the literature relating to the operating efficiency of Libyan banking. The policy implications relate to banks' specific management. Respective banks should strive to attain optimal utilization of the capacities that they have like inputs or resources, and improve their managerial expertise particularly on exercising efficient allocation of scarce resources. By doing these, they can easily achieve economies of scale for their banks. Eventually, those efforts may facilitate sustainable competitiveness for the commercial banks, private banks and specialized banks in Libya.

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