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Is Bahrain Banking Industry Efficient?

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ABSTRACT

A study undertaking to measure the efficiency of the banking industry in Bahrain and the factors determining that efficiency has been conducted. Utilizing a two-stage Data Envelopment Analysis (DEA) to measure the efficiency level in the first stage, through a balanced panel encompassing 15 banks in Bahrain, to compare the efficiency over the period 2008-2016. A second stage DEA analysis was carried out in which banking efficiency scores were regressed against alternative proxy variables for country- and bank-specific variables. According to the study, the efficiency rate in Bahraini banks rose between 2008 and 2011 buthas since declined. Ineffective scale was the principal source of inefficiency for Bahraini banks, as their return to scale was decreasing. Bahraini policy- makers and regulators should therefore refrain from supporting business expansion in the banking sector. A negative sign is confirmed by the capital variable (CAR). The credit risk indicator, LNP, had a significantly negative impact on bank efficiency. Banks which had lower ratios of loan loss reserves to total loans exhibited higher efficiency. Originality/value: There is no literature related to the Bahraini banking industry that explores the concept of two-stage DEA. This study aims to fill a gap in the literature by providing a research perspective on Bahrain's banking industry. There has been no previous study that evaluated the efficiency of Bahraini banks and evaluated the factors determining it.

INTRODUCTION

It is essential for both developed and underdeveloped countries to pursue expansionary fiscal and monetary policies to achieve rapid macroeconomic growth. In the Gulf Cooperation Council (GCC), Bahrain is among the largest financial hubs. Bahrain's financial industry is one of its major contributors to the country's GDP. Though, the global financial crisis that began in 2008 exposed Bahrain's banking sec tor's vulnerability internationally and within the Gulf Cooperation Council. According to Espinoza & Prasad (2010), the GCC banks had increased their (CR) during the crisis. It is considered one of the most important financial intermediaries in the economy, facilitating the flow of funds from lenders to borrowers, and one of the main components of the financial system. Considering this, the banks' principal functions

include receiving deposited funds from creditors as well as lending those funds to borrowers. In this process, between savers and borrowers, an intermediation takes place between them, which facilitates the flow of funds to debtors, consequently motivating investment and, thereby, contributing to overall economic growth (Drake & Fabozzi, 2010).

In the literature, considerable attention has been given to the question of whether banks outperform or underperform their competitors. It is well documented that banking efficiency is a key indicator of economic performance in advanced economies, but studies on the efficiency of Middle Eastern banks are rare. There is, to the best of our knowledge, only a limited amount of research available on Bahraini banks' efficiency. In most Middle Eastern countries, such as Bahrain, the introduction of banking reforms was not introduced until the 1990s, thus there is a lack of research. It has historically been the case that the financial sector has been heavily regulated and dominated by the public sector (United Nations, 2005). Yet, since the mid-1990s, most countries in the Middle East have adopted more liberal economic policies. The examination of the efficiency performance of banks in Middle Eastern countries over time has attracted the interest of policy makers, managers, and economists in recent years.

The study analyzes the uses of Data Envelopment Analysis (DEA), one of the most effective methods for determining appropriateness and benchmarking that has been applied to real-world problems in a variety of sectors, including the banking sector (Tsai et al., 2017). Non-parametric estimation is used to estimate Decision Making Units (DMUs) since the efficiency frontier does not need to be specified (Diallo, 2018). In order to rank Bahraini banks in terms of their efficiency scores, this study assesses banks' efficiency, and factors that may affect their efficiency. The efficiency of the DEA-based model and its related determinants has been assessed in a limited number of studies using non-parametric (DEA) and parametric (regression analysis) methods. Neither of the above methodologies has been applied to the efficiency of Bahraini banks, claim the authors.

The paper is structured as follows. The literature review is presented in section 2. Section 3 gives an overview of the technical efficiency estimates and provides an estimate of the banks' efficiency level with the second stage DEA method. In section 4, the study discusses the results of the estimation of efficiency score for Bahraini banks and its determinants, finally the paper concludes.

1. AN OVERVIEW OF THE LITERATURE

A variety of studies have been conducted worldwide to measure the efficiency of banks, but the comparisons for Middle Eastern countries are different from those for the rest of the world. Particularly, the studies carried out in Bahrain regarding the efficiency of banks are limited. The effectiveness of traditional banks in Pakistan and Islamic banks was examined by M. Gishkori and N. Ullah (2013) using data from 2007 to 2011. According to their findings, Islamic banks are more technically efficient than traditional banks. Inefficiency is generally attributed to pure technical reasons, while inefficiency is attributed to size in Islamic banks. All efficiency measures showed conventional banks outperformed Islamic banks according to Ahmad and Abdel Rahman (2012). Banks with conventional technology and efficient management have traditionally been considered superior. F. Kamarudin et al. (2014) examined 27 Islamic banks and 47 conventional banks operating in the GCC from 2007 to 2011in their study on the effectiveness of revenue using data envelopment analysis intermediation. Islamic banks performed worse than conventional banks. It has been established by M. Yehya et al. (2012) that there are no differences in applications submitted to banks in Malaysia, however, there may be minor differences among applications.

The study by M. Abdul-Majid et al. (2009) compares Islamic and conventional banks from the perspective of efficiency, using a sample of banks operating in 10 countries between 1996 and 2002. A measure of efficiency was obtained by applying the technique of output distance. The results indicate that Islamic banking has a greater reliance on inputs. The differences in inefficiency are statistically significant. There are considerably more inefficient banks in Sudan and Yemen, while banks in Bahrain are among those with the lowest levels of inefficiency. Because Islamic banks benefit from scale, they also exhibit relatively high returns to scale, except in Sudan. An analysis of DEA study keywords from 2015 and

2016 performed by A. Emrouznejad and G-L. Yang (2017) revealed that they ranked DEA two-stage as the second most popular keyword and the banking industry was the most prevalent field of study that made use of DEA.

As part of their investigation into banking efficiency in Europe over the period 2000-2008, G. Chortare-as et al. (2012) applied the DEA modelling method. Further analysis of the impact of regulation and su- pervision on bank efficiency is undertaken in a second stage regression analysis using truncated regres-sions, general linear models, and fractional logic estimation. G. Chortareas et al. (2013) also evaluate the efficiency level of the European banking industry using the traditional DEA model, while using the L. Simarand P. Wilson (2007) bootstrapped truncated regression analysis to assess the impact of financial freedomon bank efficiency. Studies are also being conducted on the efficiency of banks in emerging markets, asopposed to exclusively those in European markets. A study by P. Konara et al. (2019) examined the rela- tionship between foreign direct investment and bank efficiency over the period 2009-2013 by analyzing data from eight emerging market economies. According to R. Staub et al. (2010), traditional DEA models were also used to evaluate efficiency levels within the Brazilian banking industry (i.e. cost and technical efficiency). The second section analyzes the bank efficiency determinants using three different panel data specifications. Several empirical studies have developed innovative models based on DEA models and proposed improvements in this framework, such as the network DEA model (Kumar & Gulati, 2010; Liu et al., 2018, 2020; Paradi et al., 2011).

To the best of our knowledge, the topic of two-stage DEA in the literature has yet to be explored in relation to the Bahraini banking industry. In this study, the purpose is to offer a research perspective on the efficiency of banking in Bahrain to address a gap that exists in the literature. Up to now, no previous study has studied the factors determining bank efficiency and evaluated and measured the efficiency of the Bahraini banks.

2. VARIABLES, DATA AND METHODOLOGY

The aim of this study was to examine the performance of Bahraini banking institutions based on a non-parametric approach known as two-stage Data Envelopment Analysis, using 15 financial institutions and banks operating in Bahrain between 2008 and 2016. Obtaining a comprehensive analysis requires consideration of both scale efficiency and technical efficiency. A DEA model based on input has been run with the DEAP 2.1 package (Coelli, 1996), and empirical results have been obtained. P. Shewell and S. Migiro (2016) describe DEA as a non-parametric model for measuring and analyzing performance (Charnes et al. 1978). By applying this method, efficiency can be assessed more precisely through a non-parametric efficiency frontier, which facilitates the assessment of the efficiency of a group of peers or asingle Decision-Making Unit (DMU).

2.1 Dataset

Based on the Bank Scope database that includes detailed information on pre-calculated financial ra-tios, income statements and balance sheets, the study sampled 15 banks from Bahrain. Our data cover-ing the years 2008 to 2016, as well as 135 observations. See Table 1.

Table 1. Sample Banks on Bahrain

Bank Name	*Total Assets*
Ahli United Bank BSC	31322.5
Al Baraka Banking Group	23425.3
BBK	9847.34
National Bank of Bahrain	7917.819
Al-Khaleeji Commercial Bank	2034.572
Eskan Bank	1693.635
Alubaf Arab International Bank	1180.9
First Energy Bank	1072.5
BMI Bank	950.7979
Bahrain Commercial Facilities Company	932.9787
Future Bank	813.0319
Ibdar Bank	387.9
Oasis Capital Bank	241.4
Gulf One Investment Bank	90.9
Addax Bank	31.7

Source: Bank Scope database

2.2 Input and Output DEA First Stage

A variety of approaches in banking theory literature can contribute to a better understanding of the choice of inputs and output variables required to evaluate bank performance in DEA. There are three main types of approaches considered by some authors: the production approach, the profitability approach, and the intermediary approach (e.g. Paradi et al. 2011, Tsolas et al. 2020, Novickyte and Drodz, 2018). As per the production approach, banks perform an activity that involves producing services (for example, lending and deposits) for their account holders, by using their capital or other resources (Said et al., 2017). In a profitability approach, banks are viewed as profit-seeking; therefore, maximizing in- come and minimizing expenses (e.g., interest payments and non-interest expenses) is prioritized (Novickyte and Drozdz, 2018). According to the intermediation approach, banks provide loans and other assets (investments) to clients using labor, operational costs, and capital (i.e., collected funds) (Ouenniche & Carrales, 2018).

A variable's choice may also be influenced by whether necessary data is available. Net income can be considered an output for the study by Du et al. (2018) and non-interest expenses can be considered an input. For the model used in this study, Table 2 lists the variables. The data for the study were primari-ly obtained from Bank Scope databases.

Table 2. Bahrain banks' list of inputs and outputs

Variables	*DEA Model*
Inputs	Interest Iincome
	Non-interest income
Outputs	Interest expense
	Non-interest expense

2.3 The Estimates of Technical Efficiency

We evaluate Bahrain's banking industry's technical efficiency based on the DEA approach. Technical efficiency can be broken down into its constituent parts, which are "pure technical efficiency" and "scale

efficiency". As part of a method known as multi-scaled estimation, there are two types of models: constant return to scale (CRS) and variable return to scale (VRS). A DEA score is estimated to be between 0 and 1, where 1 indicates that a system is fully efficient while zero indicates a system that is fully inefficient (partly created by pure technical components, partly by scale efficiency components). A DMU's efficiency can be measured against that of others by comparing the results of this equation. A bank's efficiency rating reflects how efficiently it can transform inputs into outputs. Coelli et al. (2005) give an over view of these alternative approaches. DEA models are run in DEAP Version 2.1 (Coelli, 1996) using input-oriented DEA models to obtain the empirical results. The study used data from Bahraini banks from 2008 to 2016. Among empirical studies involving cross-sectional data, the intermediation approach has been widely employed (Colwell and Davis, 1992; Favero and Papi, 1995).

2.4 Determenent of Bank Efficiency

Within the scope of the DEA, environmental factors can contribute to improved banking efficiency (Jreisat and Bawazir, 2021; Zhao et al., 2017). Tobit, OLS, and GMM models are then regressed on envi-ronmental variables in the second stage of the DEA. According to Coelli et al. (2005), in the first stage ofDEA, efficiency scores are calculated. These models are widely used in banking research.

To estimate technical efficiency, DEA was used in Stage 1. During Stage 2, the analysis was regressed against a vector of explanatory variables (x), which may have been impacting efficiency. In addi tion to omitting the bounded nature of the dependent variable, the OLS estimator also assumes a linearconditional mean model for Efficiency (Ef):

$$E(Ef/x) = x\beta \qquad (1)$$

Since the Ef is strictly bounded above and below, it cannot be assumed that the explanatory variable's impact is constant. By using linear specifications, TE values can only be predicted to range between 0-1 if x is severely constrained or if arbitrary changes are made to fitted values outside the unit interval. Empirical economists prescribe logistic correlation in order to solve this problem since it determines.

$0<E(\frac{Ef}{x})<1.$

$$E(Ef/x) = \frac{e^{x\beta}}{1+e^{x\beta}} \qquad (2)$$

Equation (3) does not estimate directly but converts to log-odds model. Estimation was done via OLS.

$$\left(ln\frac{Ef}{1-Ef}\middle|x\right) = x\beta \qquad (3)$$

The two drawbacks of the above model are: (i) Recovering $E(Ef/x)$ from (4) is not straightforward (Papke and Wooldridge, 1996) and (ii) Equation (3) is inapt for TE boundary values of 0 and 1. As the DEA-based frontier estimator groups at least a firm to be completely efficient (Ef=1), Equation (3) was omitted.

According to Tobit, some scholars have limited predicted Ef scores to 0-1 using the Tobit model. Themodel, however, does not apply to observations where there are both limits - a situation that is not fre- quently encountered in efficiency research. Prior to performing filtering on the Tobit model, the dependent variable must meet the restrictive assumptions of normality and homoscedasticity.

Our study examined other factors that influence technical efficiency levels to improve regulatory policy management by policy makers and bankers. Thus, we applied the technique suggested by Papke andWooldridge (1996).

In cases in which the independent variables can be estimated using a straightforward procedure, Papke and Wooldridge's estimation method eliminates the need to adjust the dependent variables at extreme values of 0 or 1. Consequently, the dependent variable should be predicted to range from 0 to 1. We implemented this using the Bernoulli log-likelihood function:

$$l_{it}(\beta) = Ef_{it}\log[G(x_{it}\beta)] + (1 - Ef_{it})\log[1 - G(x_{it}\beta)] \quad (4)$$

where 0 < G (.) <1 is logit function, y_i denotes efficiency, and vector X signifies independent variable. Estimates 1 for parameter B were gained by maximising the log-likelihood for the sample (banks) throughout 2003-2016. The maximisation problem is expressed as follows:

$$\max_{\beta} \sum_{t=1}^{9}\sum_{t=1}^{64} l(\beta) \quad (5)$$

The estimated variance-covariance matrix is as follows: $\hat{V} = \hat{A}^{-1}\hat{B}\hat{A}^{-1}$ where A and B are given by

$$\hat{A} = (N \times T)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{g}_{it}^{2}x_{it}^{'}x_{it}[\hat{G}_{it}(1-\hat{G}_{it})]^{-1}$$ and

$$\hat{B} = (N \times T)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{u}_{it}^{2}\hat{g}_{it}^{2}x_{it}^{'}x_{it}[\hat{G}_{it}(1-\hat{G}_{it})]^{-2}$$,

respectively, where $\hat{G}_{it} = G(x_{it}\hat{\beta})$, $\hat{g}_{it} = g(x_{it}\hat{\beta})$, $g(x\beta) = \partial G(x\beta)/\partial x\beta$ and $= Ef_{it} - \hat{G}_{it}$

3. DISCUSSION AND RESULTS

3.1 Evaluation of Efficiency

To measure efficiency of Bahrain banks the DEA output based VRS was deployed to maximise bank output. In Table 3 we represent the variances of inputs and outputs over the study period. Net interest expense had a minimum value of USD 0.1 million and a maximum value of USD 1242.3 million, with an average of USD 101.2 million and a standard deviation of USD 231.6 million.

Table 3. A statistical summary of the input and output variables (in Millions USD)

Variables	*Mean*	*Stand. Dev.*	*Min*	*Max*
Inputs				
Net interest expense	101.2	231.6	0.1	1242.3
Non-interest expense	78.4	123.5	0.8	532
Outputs				
Interest income Non-interest income	213.2 59.8	402.7 101.7	0.1 1	1764 537

Source: authors calculations

As shown in Table 4, Stage 1 results DEA are presented the efficiency level for each bank in the sample (TE, PE, and SE). During the sample period, the efficiency scores exhibited the highest efficiencylevel for Ahli United Bank for TE, PE, and SE with an average of 70.1%, 81.5% and 84%, respectively, which means the bank should improve technical efficiency by 29.9% to be fully efficient and this inefficiency is attributed due to the scale inefficiency. In another word, the mean technical efficiency TE scorefor Ahli United Bank shown a was 0.70.1, this translates to an increase in banking efficiency of 0.299 (29.9%) as full efficiency was not achieved due to several factors, including fluctuations brought

about bythe global financial crisis at that time and the oil price decline. Thus, according to this result, banks are able to save up to 29.9% in input during business operations if they are able to maintain constant output. Based on these findings, it can be concluded that the Bahrain banks performed relatively well over the period 2003 - 2011. Interestingly, the efficiency score in the mid-period of our sample were the highest comparing with the rest of the years, eight banks had more than 80% efficiency score, two banks of the sample on 2011 were shown a fully efficient score (BBK and Al Baraka Banking Group). Honever, necessary to increase the efficiency of the banking system in Bahrain to improve its performance. In addition, the lowest efficient bank in our sample sorted to Bahrain Commercial Facilities with an average of 35.9%, 53% and 71% TE PTE and SC, respectively. Most of the banks revealed to have on average technical efficiency score between (39%-71% - See table 4).

The efficiency level of each bank in the sample is even more interesting to analyze. On the next two figures (Figure 1 and Figure 2), we show the average efficiency of all 15 banks in the sample for the examined period. Among the sample, the four best performing banks are BBK, Ahli United Bank, Alubaf Arab International Bank, and Al-Khaleeji Commercial Bank. Furthermore, Bahrain Commercial Facilities Company,Oasis Capital Bank, Gulf One Investment Bank, and Addax Bank were among the worst performing banks. As a result of this finding, prudent policies can be devised by banks to improve their performance,especially those with very low levels of efficiency, by communicating with, and learning from, the banks with the highest efficiency within the same sample of banks.

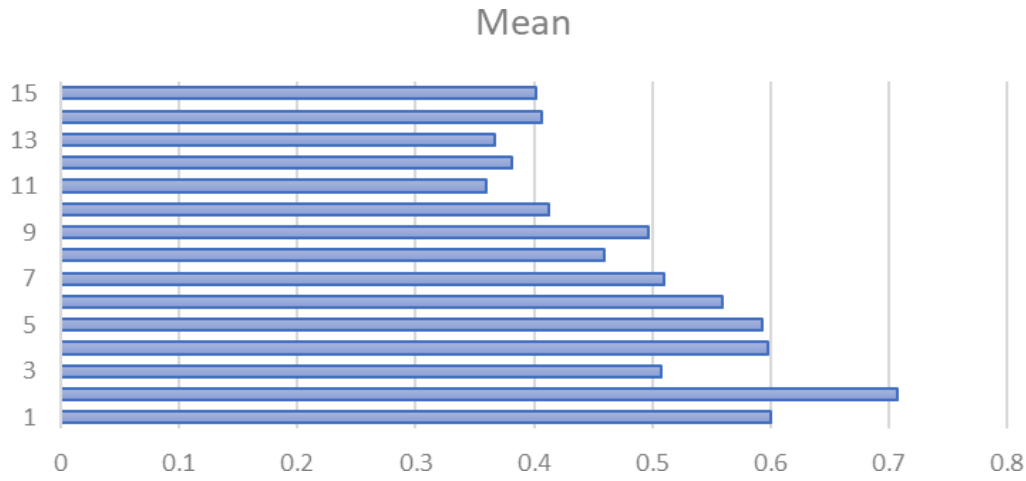

Figure 1. Technical Efficiency level for each Bank on Bahrain

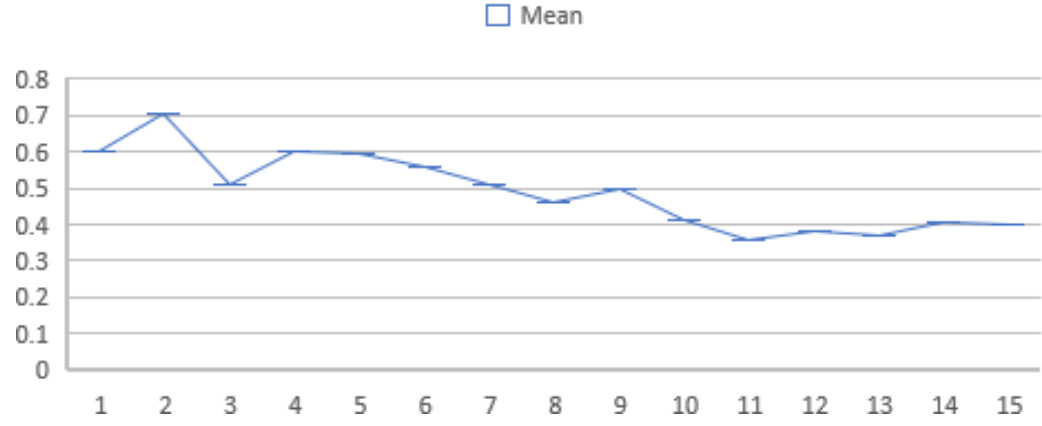

Figure 2. Technical Efficiency level for each Bank on Bahrain

To gain a more comprehensive understanding of the efficiency level among the banks in the sample, we have produced the figure below (Figure 3), which represents the efficiency level within the Bahraini banking industry from 2008 to 2016. It can be seen from Table 5 and Figure 3 that the Bahraini banking industry has experienced a greater degree of volatility in efficiency scores over the assessment period. Ingeneral, efficiency levels have been increasing steadily up to 2011, following which efficiency levels began declining in 2012, and although a slight decline in efficiency levels can be observed in 2013 in comparison to 2016, this decrease continues until the efficiency score reaches 0.274 (27.4%) in 2016. Table 5 consequently, presents the efficiency level for the sample period (TE PE and SE). According to our analysis of TE, PE, and SE (49.6%, 69.4%, and 70.6%), the Bahrain banking industry was the most efficient and effective from 2008 – 2011, with levels of (TE, PTE, and SC) efficiency of 0.70, 0.75, and 0.89, on the year 2011. Overall, the efficiency level for Bahrain banks decreased during the sampleperiod, especially during the period following the 2012.

Table 4. Evaluation of Bahraini Banks' Technical, Pure Technical, and Scale Efficiencies

Bank name	*EFF*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Mean*
BBK	TE	0.59	0.71	0.99	1.00	0.34	0.65	0.43	0.43	0.22	0.60
	PTE	0.95	0.98	1.00	1.00	0.46	1.00	0.56	1.00	0.58	0.84
	SCE	0.62	0.72	0.99	1.00	0.73	0.65	0.76	0.43	0.38	0.70
Ahli United Bank	TE	0.46	0.74	0.99	0.96	0.44	1.00	0.44	1.00	0.31	0.70
	PTE	0.74	1.00	1.00	0.96	0.56	1.00	0.54	1.00	0.51	0.81
	SC	0.62	0.74	0.99	0.99	0.78	1.00	0.80	1.00	0.61	0.84
National Bank ofBahrain	TE	0.45	0.72	0.91	0.75	0.38	0.33	0.45	0.18	0.35	0.50
	PTE	0.75	1.00	0.91	0.80	0.56	0.79	0.55	0.42	0.58	0.70
	SC	0.59	0.72	0.99	0.94	0.69	0.42	0.82	0.43	0.61	0.69
Alubaf Arab International Bank	TE	0.46	0.63	1.00	0.94	0.55	0.60	0.47	0.27	0.42	0.59
	PTE	0.82	0.82	1.00	1.00	0.77	1.00	0.56	0.55	0.62	0.79
	SC	0.56	0.76	1.00	0.94	0.71	0.60	0.85	0.48	0.68	0.73
Al-Khaleeji Commercial Bank	TE	0.47	0.62	1.00	0.83	0.53	0.26	0.46	0.34	0.79	0.59
	PTE	0.77	0.87	1.00	0.90	0.75	0.65	0.63	0.34	0.79	0.74
	SC	0.61	0.71	1.00	0.92	0.71	0.40	0.72	1.00	1.00	0.78
Future Bank	TE	0.46	0.62	0.62	0.92	0.50	0.14	0.43	0.46	0.85	0.55
	PTE	0.76	0.87	0.63	0.97	0.72	0.36	0.65	0.46	0.85	0.70
	SC	0.61	0.71	0.97	0.94	0.70	0.39	0.66	1.00	1.00	0.77
BMI Bank	TE	0.54	0.66	0.93	0.90	0.49	0.27	0.42	0.15	0.18	0.51
	PTE	0.85	1.00	1.00	0.95	0.79	1.00	0.68	0.22	0.40	0.76
	SC	0.63	0.66	0.93	0.95	0.62	0.27	0.61	0.70	0.45	0.65

(Continuous Table 4)

Bank name	EFF	2008	2009	2010	2011	2012	2013	2014	2015	2016	Mean
Al Baraka Banking Group	TE	0.52	0.70	0.64	1.00	0.49	0.14	0.43	0.17	0.24	0.46
	PTE	0.82	1.00	0.70	1.00	0.89	0.43	0.75	0.17	0.31	0.64
	SC	0.64	0.70	0.91	1.00	0.55	0.33	0.58	1.00	0.44	0.68
First Energy Bank	TE	0.55	0.67	0.73	0.95	0.49	0.23	0.45	0.32	0.26	0.49
	PTE	0.86	0.96	0.95	0.96	1.00	0.51	0.75	0.32	0.28	0.70
	SC	0.63	0.70	0.77	0.98	0.49	0.46	0.60	1.00	0.93	0.73
Ibdar Bank	TE	0.69	0.65	0.66	0.44	0.50	0.21	0.29	0.08	0.16	0.41
	PTE	1.00	0.99	1.00	0.54	0.93	0.39	1.00	0.13	0.18	0.68
	SC	0.69	0.65	0.66	0.82	0.53	0.54	0.29	0.61	0.87	0.63
Bahrain Commer-cialFacili-ties Com-pany	TE	0.66	0.64	0.42	0.39	0.50	0.22	0.18	0.12	0.06	0.35
	PTE	0.93	1.00	0.45	0.48	0.97	0.27	0.42	0.14	0.10	0.53
	SC	0.71	0.64	0.92	0.80	0.52	0.80	0.43	0.89	0.64	0.71
Oasis Capi-tal Bank	TE	0.64	0.62	0.33	0.33	0.51	0.24	0.39	0.19	0.14	0.38
	PTE	0.89	0.94	0.38	0.43	1.00	0.45	0.45	0.25	0.50	0.59
	SC	0.71	0.66	0.88	0.77	0.51	0.53	0.86	0.77	0.28	0.66
Gulf One Investment Bank	TE	0.64	0.79	0.41	0.31	0.32	0.15	0.41	0.18	0.05	0.36
	PTE	0.89	1.00	0.49	0.43	0.32	0.15	0.75	0.44	0.14	0.51
	SC	0.72	0.79	0.85	0.72	1.00	1.00	0.54	0.41	0.36	0.71
Eskan Bank	TE	0.6	0.53	0.49	0.34	0.71	0.13	0.30	0.18	0.24	0.40
	PTE	0.98	0.59	0.57	0.44	0.71	0.23	1.00	0.47	1.00	0.66
	SC	0.71	0.905	0.860	0.779	1.000	0.583	0.309	0.384	0.24	0.64
Addax Bank	TE	0.71	0.64	0.54	0.36	0.48	0.13	0.26	0.21	0.24	0.40
	PTE	0.97	0.65	0.63	0.46	0.61	0.31	1.00	0.56	1.00	0.69
	SC	0.73	0.99	0.85	0.78	0.78	0.41	0.26	0.38	0.24	0.60

Source: Author's calculations. Eff refers to Efficiency, TE to Technical Efficiency, PTE to Pure Technical Efficiencyand SE to Scale Efficiency.

As a result, the results reported in Table 5 reveal that the technical efficiency of Bahrain's sample banks was very low. A score of 71% was the highest technical efficiency in 2010, while a score of 27% was the lowest. These empirical findings add significantly to the limited literature on the performance of Bahrain banks and make an important contribution to the literature. In addition, using the DEA approach enabled us to gain insight into any inefficiencies in input-output processes that Bahraini banks may have experienced during the sample period. Despite the rise in efficiency from 2008 through 2011, from 2012 through 2016, the score has declined, which can be attributed to the decrease in world oil prices.

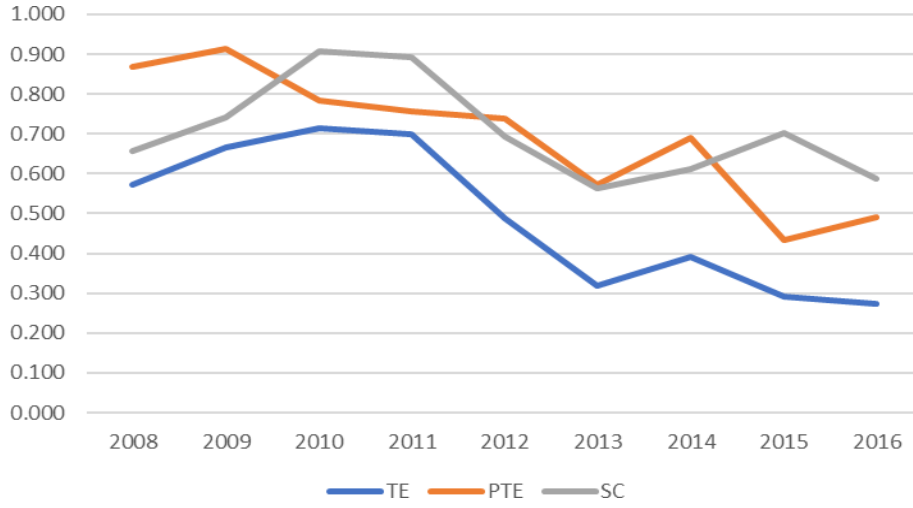

Figure 3. Mean Efficiency level in the Bahrain banking industry

Table 5: The annual means of technical, pure technical, and scale efficiency for Bahrain's banks

Year	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Mean*
Eff										
TE	0.57	0.66	0.71	0.70	0.48	0.31	0.39	0.29	0.27	49.1
PTE	0.86	0.91	0.78	0.75	0.73	0.57	0.68	0.43	0.49	69.4
SC	0.65	0.74	0.90	0.89	0.69	0.56	0.61	0.70	0.58	70.6

Source: Author's calculations. Note: Mean levels are geometric means. Eff denotes Efficiency, TE Technical Efficiency, PTE Pure Technical Efficiency and SE Scale Efficiency.

3.2 Determinants of Bank Efficiency

In Stage 2 DEA, banking efficiency scores were regressed against alternative proxies for country and bank-specific variables. Table 7 lists the statistical tests deployed in Stage 2 DEA, where the estimated banking efficiency scores were regressed against a vector of explanatory variables that may affect the banking efficiency scores. Our results finding which is in line with our priors and the academic literature. Table 6 shows the descriptive statistics of the variables in the current study for stage 2 DEA.

Table 6. Descriptive analysis of TE, country and bank-specific variables (in Million USD)

Variable	*Observation*	*Mean*	*Std. Dev.*	*Min*	*Max*
TE	135	0.49	0.26	0.01	1.00
INF	135	2.36	1.11	-0.40	3.53
GDPG	135	0.28	2.22	-3.55	4.21
NLP	135	14.39	39.88	0.32	220.00
SIZE	135	4811.47	8270.16	31.70	33965
CAR	135	40.71	32.68	8.51	99.78
ROE	135	4.07	16.48	-119.87	37.29

Source: Author's calculations

Each variable is expressed in million US dollars. A bank's size is measured by its total assets. Net in-come (ROE) is calculated by the ratio of it to its total equity. LNP means loan loss reserves (% of total loans); CAR means equity assets (% of total assets).TE is the calculated score based on the DEA stage 1estimate of technical efficiency.

Table 7 presents our results; it was noted that the estimated coefficients for INF (macroeconomic variable) was insignificant with expected signal. Apparently, negative, and statistically significant link was identified between banking efficiency and CAR. Sufian (2009) concluded an adverse correlation for the said variables. Retaining an exceptional CAR can be costly to banks, which in turn, can adversely affect their efficiency (Altunbas and Marqués, 2008). In addition, as for equity to total assets, CAR displayed a significantly negative effect on banking efficiency. In fact, our finding agrees with the finding on BRICS countries study Ben Jabra et al. (2017), which stressed, a negative coefficient indicates the non-financialsoundness of banks as more funding needs long-term decline. This result confirms the negative sign of the capital variable (CAP). Athanasoglou et al. (2005) and Berger (1995) showed that well-capitalised banks are considered less risky meaning that they have a better access to funds at acceptable conditions even in the presence of information asymmetry.

Table 7. Statistical analysis of the Bahrain Banks in the second stage regression (GLM)

TE-Eff	*Coef.*	*Std.*
INF	-0.036	0.072
GDPG	0.010	0.032
NLP	-0.002***	0.001
SIZE	-9.693	8.051
CAR	-0.011***	0.002
ROE	0.044***	0.006
Constant	0.277***	0.245

Source: The author's calculations. There is a ***, **, and * signifying 1%, 5% and 10% significance levels, re-spec-tively, with Asymptotic standard errors in parentheses. GLM is a generalized linear model.

As for credit risk indicator, LNP displayed a significantly negative effect on banking efficiency. In fact, banks with lower ratios of loan loss reserves to total loans appeared to display better efficiency. Loan loss reserves denote the anticipated losses by bank managers, while higher LNP reflects the higher fraction of assets placed by banks for potential loan repayment defaults. As loan offerings are the key bankactivity in the GCC nation, higher losses of loan directly affected BE in a negative manner. Besides, BE had an adverse effect on credit risk (Al-Muharrami, 2007; Moussawi and Obeid, 2011).

Referring to Table 8, SIZE had an insignificantly negative impact on banking efficiency, signifying lower banking efficiency with larger bank assets. However, in Bahrain case, there is no matter of size variable as its insignificantly with efficiency of banks.

CONCLUSION

In this study, 15 banks were evaluated over a period of nine years to determine their efficiency. According to the study, the banks scored 0.49 percent during the entire period of the study, which is a verygood result. In conjunction with economic progress, inflation may have been two of the primary prerequi-sites for BE in GCC nations. For the first stage, DEA was applied to estimate the Bahraini banking indus-try's efficiency level, for the second stage, DEA was applied to regress efficiency scores against a vector of explanatory variables to conduct the analysis.

Our study provides us with some interesting empirical findings that provide an important contribution to the literature on Bahrain bank performance as well as adding to the limited literature previously available. Furthermore, we investigated Bahrain's input-output inefficiencies because of implementing the DEA approach during the sample period. From 2008 to 2011, the efficiency level rose. However,

from 2012 to 2016, it declined, likely because of the fall in oil prices in 2016. Moreover, according to our analysis, the top four best performing banks in the sample are Bahrain Banking Company (BBK), Ahli United Bank (AUB), Alubaf Arab International Bank (AAIB), and Al-Khaleeji Commercial Bank (AKCB). The worst performing bank is Gulf One Investment Bank, followed by Bahrain Commercial Facilities Company, Oasis Capital Bank, Gulf One Investment Bank, and Addax Bank. Bahrain Commercial Facilities Company is the second worst performing bank. Considering this outcome, banks with low levels of efficiency have been given recommendations for how they can improve their performance by getting in touch with and learning from the banks performing extremely well in the sample.

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