Comparison Of Efficiency And Productivity Changes Of Islamic And Conventional Banks: Evidence From Europe And Muslim-Majority Countries?

Ahmad M. Abu-Alkheil, Ph.D. Student, University of Hohenheim - Schloss, Germany
Hans-Peter Burghof, Ph.D., University of Hohenheim - Schloss, Germany
Walayet A. Khan, Ph.D., University of Evansville, USA

ABSTRACT

This paper examines the efficiency performance of Bosna Bank International (BBI) in Bosnia-Herzegovina and Islamic Bank of Britain (IBB) in the UK, against small conventional banks in each country and also against small and large Islamic banks from Muslim-majority countries. This paper also estimates the productivity changes of IBB and BBI relative to small Islamic banks, within and outside Europe, and relative to small conventional banks in the UK and Bosnia respectively. Finally, this paper utilizes OLS regression analysis to check the robustness of the overall data envelopment analysis (DEA) results, as well as to determine the impact of internal and external factors on bank's efficiency. The analysis covers the 4-year period from 2005 through 2008. The findings suggest that IBB and BBI are technically inefficient. In comparison with small banks, inefficiency is largely due to mismanagement. Inefficiency becomes scale in nature relative to large Islamic banks. As compared to Islamic banks, BBI yields higher pure technical efficiency than IBB, but IBB records higher positive growth in estimated efficiency. IBB and BBI yield upward growth in total factor productivity and technical efficiency but record negative growth in technology innovations. Results also suggest that the IBB and BBI lag relatively behind their conventional peer banks in terms of efficiency and productivity performance. BBI shows much better efficiency performance relative to conventional banks than IBB. Overall, a bank that is more efficient is found to be larger, more profitable, acquire less debt, invest more in skills, and operates in countries with a higher GDP per capita.

Keywords: Islamic Banking, Efficiency Performance, Productivity Growth, European Banking Sector

1. INTRODUCTION

The efficiency and productivity of banks have been widely studied in the literature. For banks, efficiency implies improved profitability, large deposits (funds), better prices, quality services and greater safety in terms of improved capital buffer in absorbing risk (Berger, Hunter, and Timme, 1993). Hence, the information obtained from the evaluation of the bank's performance may be used to improve its efficiency as well as to increase productivity. Overall, the analysis of banks' performance is important for European banking where Islamic banks are operating in parallel with conventional banks. Measuring the efficiency and/or productivity of Islamic banks in Europe provides evidence on the performance of Islamic banks as compared to European counterparties-conventional banks. It further contributes towards examining the validity, stability and viability of Islamic banking in a system that is driven by conventional regulations. This could also make European banks perceive Islamic banking as a profitable opportunity to generate new business rather than as a threat to existing business taking into consideration the uncomfortable opinion of some non-Muslims on Islamic values and principles.

Islamic banking is a worldwide phenomenon involving a variety of instruments. Previously, Islamic transactions and institutions made up a small part of the total banking industry. Recently, Islamic banks have significantly expanded their network and have been able to mobilize large amount of funds and upgrade many economic ventures. Given the differential behavior of the Islamic banks and the conventional banks[1], there has been a question about the long run sustainability of Islamic banks, which in turn depends heavily on their economic efficiency. A bank is considered to be economically efficient if it exhibits technical efficiency. A bank is technically efficient if it produces the maximum output from a given set of inputs (Yotopulas and Lau 1973).[2]

Despite the considerable development of the Islamic banking sector, there are still few studies that focus on the efficiency and productivity growth of Islamic banks, particularly in Europe. Past studies concentrated primarily on conceptual issues. In this paper, our primary contribution is to offer a comprehensive analysis of the efficiency and productivity changes of Islamic banking in Europe. We intend to identify financial and policy indicators that impact performance of Islamic banks. Due to the short history of Islamic banking in Europe and consequently lack of sufficient data, we utilize a sample period of 4-years, 2005 (2 years pre-crisis of 2007) through 2008, to examine the relative efficiency performance of the first and only Islamic commercial banks in Europe i.e. Bosna Bank International (BBI) in Bosnia – Herzegovina (BiH), and Islamic Bank of Britain (IBB) in the UK. More specifically, we compare their efficiency performance with small conventional banks in each country, on the one hand, and with small and large Islamic commercial banks from Gulf Cooperation Council (GCC)-States (i.e. Bahrain, Kuwait, Qatar, Saudi Arabia, United Arab Emirates, and Oman), Malaysia, Turkey and Azerbaijan, on the other hand. We further aim to measure the productivity changes of IBB and BBI in relation to small Islamic banks, within and outside the Muslim-majority countries, and also relative to small conventional banks in the UK and BiH respectively.

We *first* employ the non-parametric (DEA) technique to estimate the relative efficiency scores for Islamic and conventional banks over the sample period 2005-2008. *Second*, in order to measure the changes in productivity, we apply the Malmquist-DEA method to calculate the Malmquist Total Factor Productivity (TFP) indices. *Third*, the DEA-efficiency scores obtained from the first stage are used as dependent variables in the Ordinary Least-Squares (OLS) regression analysis in order to examine the effects of the environmental factors (variables that are neither considered inputs nor outputs such as: the bank‘s size and region, etc.) on each banks' performance. OLS is also utilized to check the robustness of the overall results obtained from DEA scores. Such an analysis is important both from operational as well as academic viewpoints. It displays the expansion potential for Islamic banks in a hybrid banking system, as well as showing guidelines implications for Islamic banks on how to improve efficiency and productivity growth.

The rest of the paper is organized as follows: Section 2 reviews the literature. Section 3 discusses the methodology and calculations of DEA first stage of analysis as well as calculations for the Malmquist index. It further considers the DEA-second stage analysis. Section 4 presents the empirical results. Finally, section 5 contains the concluding remarks.

2. LITERATURE REVIEW

The literature on the comparative efficiency and productivity, particularly in the area of conventional banking, comprises a large number of papers. Likewise, the literature on Islamic finance has grown recently, reflecting the increased role of Islamic banking particularly in Muslim countries. The bulk of the academic work in the area of Islamic banking is related to comparisons of the instruments used by Islamic and conventional banks and the regulatory and supervisory challenges related to Islamic banking, e.g. Omar, Abdul Rahman, Yusof, Abd. Majid and Rasid (2006), Sole (2007), and Abdul-Majid, Saal and Battisti (2008).

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[1] Islamic banking is a form of banking based on Islamic principles. Basically, Islamic banking does not allow the paying and/or receiving of interest. It is based on profit and loss sharing. Islamic banks must avoid heavy debt, excessive uncertainty, speculation, and socially and ethically detrimental activities. In Islamic banking, money itself has no intrinsic value; it is simply a medium of exchange. Each financial transaction in Islamic banks must also be tied to a tangible underlying asset.

[2] "When two banks produce the same amount of output but bank (A) uses less inputs than bank (B), bank (A) is said to be more efficient, from the technical efficiency point of view. Alternatively, if (A) and (B) use the same amount of inputs but (A) manages to produce more output, then, too, it is more technically efficient" (La Forgia and Couttolenc, 2008).

Empirically, Hussein (2003) examines the cost efficiency of Islamic banks in Sudan between 1990 and 2000. Using the stochastic cost frontier approach, Hussein estimates cost efficiency for a sample of 17 banks. The results show large variations in the cost efficiency of Sudanese banks, with state owned banks the most cost inefficient, while the smaller banks are more efficient than their larger counterparts, and the foreign owned banks are the most efficient.

Hassan (2005) evaluates the relative cost, profit, x-efficiency, and productivity of 43 Islamic banks in 21 countries. The study covers the period of 1993-2001. He uses both the Stochastic Frontier Approach (SFA) and the (DEA) technique as tools to examine the efficiency. He calculates five efficiency measures: cost, allocative, technical, pure technical, and scale efficiency. He also correlates the efficiency scores with the conventional accounting measures of performance. The results indicate that the Islamic banking industry is relatively less efficient compared to its conventional counterparts. The overall inefficiency is, by and large, output related, with the main source of inefficiency being allocative rather than technical in nature. Findings also suggest that the Islamic banks are more profit-efficient. The results eventually show that the efficiency measures can be used concurrently with conventional accounting ratios in determining the performance of Islamic banks.

Sufian (2006) examines the efficiency of the Malaysian Islamic banks during 2001-2004 by using the DEA method. Findings suggest that the banks scale inefficiency outweighs pure technical inefficiency. This implies that Malaysian Islamic banks have been operating at a non-optimal level (scale) of operations. Results also show that the domestic Islamic banks have exhibited a higher technical efficiency compared to their foreign Islamic banks peers.

In 2007, Sufian extended his empirical work by directly examining the antecedents of the Malaysian Islamic banking sector's productivity changes over 2001-2005. The study employs the (MPI) to measure efficiency and technological changes. Findings suggest that the Malaysian Islamic banking sector has exhibited decline in productivity, largely due to the decline in technological advancement. Foreign Islamic banks have exhibited lower productivity levels compared to their domestic peers, and the domestic Islamic banks have exhibited higher productivity levels compared to their foreign peers, attributed to higher technological progress and efficiency levels.

There is a small body of empirical literature that offers comparisons of the financial and efficiency performance of Islamic and conventional banking, e.g. Rosly and Bakar (2003), Samad (2004), Yudistira (2004) and Limam (2001). More recently, Johnes, Izzeldin and Pappas (2007) examined the efficiency for Islamic and conventional banks in the GCC-region during 2004-2007. They used financial ratio analysis (FRA) and the (DEA) method. Based on the FRA, Islamic banks were found to be less cost efficient but more efficient than conventional banks in revenue and profit. Results from the DEA reveal that the average efficiency in Islamic banks is lower than conventional peers.

Despite the above discussed literature, empirical researches on the efficiency and productivity of Islamic banks are still in their infancy in Muslim countries and rare in Europe. This is due to the lack of sufficient data and the short presence of Islamic banks. Thus, the main purpose of this paper is to bridge this gap in the cross-country literature.

3. METHODOLOGY

The next sub-sections (3.1-3.2) present the application of the DEA approach for efficiency analysis, the DEA-based Malmquist productivity index (MPI) method, and the second-stage of DEA analysis.

3.1. Data description and variables

We utilize the DEA-technique to calculate the efficiency scores of the sample banks. We then adopt the MPI technique to measure the contributions of technology in promoting efficiency (technical change). Such a technique is considered to be evidence of innovation and improvement in efficiency. We estimate DEA efficiency scores and Malmquist indexes using DEA*P* version 2.1, a program developed by Coelli (1996). There are a number of desirable features of the DEA model for our particular study. DEA looks directly for a best-practice frontier within the data (Omar et al. 2006). The advantage of DEA is that it neither requires input nor output prices in the construction of the efficient frontier. This makes the method particularly useful in the case where prices are not available publicly or do not exist. Furthermore, DEA also does not require a behavioral assumption in situations where the producer's objectives differ or are unknown or unachieved. Moreover, DEA takes into account all inputs and outputs simultaneously as well as differences in technology and capacity. It then compares a decision making unit (DMU), each of the banks in our study, with the best-practice frontier peers.

There are two main approaches that have been widely used in banking literature to define inputs and outputs: the production approach and the intermediation approach. Under the production approach, banks use various labor and capital resources to provide different products and services to customers such as loans and deposits. Under the intermediation approach, banks are viewed as financial intermediaries that collect deposits and other loanable funds and then lend them as loans or other assets for profit.

In this paper, we adopt the intermediation approach because the main characteristic of Islamic banks is that they follow the principle of interest-free and profit-and-loss-sharing (PLS) in performing their business as intermediaries (Ariff, 1988). Islamic banks employ the concept of participation in projects utilizing the funds at risk on a PLS basis. This certainly implies the importance of intermediary activities that Islamic banks perform (Yudistira, 2004). We model Islamic banks as multi-product firms, employing three-inputs and producing two-outputs. The input vectors include: (1) total deposits and short term funding, (2) total expenses, and (3) total staff costs. On the other hand, the output vectors comprise: (1) total (non) interest-bearing loans and (2) total revenues. Table 4 in the appendix reports descriptive statistics of outputs and inputs of the commercial banks during the sample period.

Using DEA, we can estimate efficiency under the assumption of constant returns-to-scale (CRS) in the CCR-model, which was proposed by Charnes, Cooper and Rhodes in (1978), and variable returns-to-scale (VRS) in the BCC-model which was initially developed by Banker, Charnes, and Cooper (1984).[3] The CRS assumption is only appropriate when all DMUs are operating at optimal scale. Factors like imperfect competition and constraints in Islamic finance may cause our sample banks not to operate well at their optimal scale of operations. On the basis of the prior arguments and to account for the fact that the sizes of the banks in our sample vary greatly, ranging from large active banks to small banks, we estimate our model under the assumption of the BCC-model as suggested by Cooper, Seiford, and Tone, (2007). Results obtained from this model are commonly called "pure technical efficiency (PTE) scores". This is because they are obtained from the model that allows variable returns to scale (VRS). Consequently, we'll be focusing in this paper on the PTE scores to examine the comparative performance of the selected banks.

Basically, when measuring efficiency using the DEA approach, there are two typical assumptions with regard to a bank's behavior: an input-oriented model, which is used to identify technical inefficiency as a proportional reduction in input usage, and an output-oriented model, where the technical inefficiency is measured as a proportional increase in output production. In this paper, we assume an output-oriented approach. Our preference for this measure is due to its reliability and as a better fit to our situation. Islamic banks operating under a competitive environment strive to offer the best possible products for their clients. Therefore, they are more likely to sustain their competitive advantage by increasing their outputs production rather than reducing the input usage.

DEA efficiency estimates, however, can be biased. Alirezaee, Howland, and van de Panne, (1998) argue that the smaller the number of DMUs is, the higher the probability the units will be overestimated. However, this is not an issue in our research design because our sample size is large enough. We follow Cooper, Seiford, and Tone, (2007) and Darrat Topuz, and Yousef, (2002) who suggest the product of inputs times outputs should optimally be less than the sample size $(I*O<n)$.

[3] The value of SE is less than or equal to one. If DMU has a value equal to one, then it is operating at a constant returns-to-scale size (CRS). If SE is less than one, then DMU is scale inefficient (operating at a variable returns-to-scale (VRS)). The scale inefficient DMU will either experience increasing returns-to-scale (IRS) due to being at less than optimum size, or decreasing returns-to-scale (DRS) due to being at more than the optimum size.

Additionally, one of the assumptions to apply DEA is that the DMUs must be homogenous units; they should be performing the same tasks and should have similar objectives. This fits well with our sample because the operation of Islamic banking is the same as that of conventional banking except that Islamic banking operates in accordance with the rules of Shari'ah. However, both Islamic and conventional banks operate with the same essential goals of earning a profit and benefitting society, even if there are some differences in how they reach these goals.

Table 1
Summary statistics of the population and the selected sample

Region- country		No. of Islamic commercial banks -per country	Selected sample banks [4]
Middle East,(GCC)			
Qatar		4	2
Saudi Arabia		5	3
Kuwait		4	2
Bahrain		6	5
U.A.E		9	3
M1*: Banks with AvTA of ≤1.5 bn £.	(7)**		
M2: Banks with AvTA of >1.5 bn £.	(8)		
Southeast Asia			
Malaysia		16	3
M1: Banks with AvTA of ≤1.5 bn £.	(2)		
M2: Banks with AvTa of >1.5 bn £.	(1)		
Eurasia			
M1:Turkey	(2)	5	2
M1: Azerbaijan	(1)	1	1
All banks have AvTA of ≤1.5 bn £.			
Europe			
M1+ M2: U.K	(1)	1	1
M1+ M2: BiH	(1)	1	1
SUM		23 out of 52	52

** Model-M1 measures the efficiency performance of IBB & BBI relative to small Islamic banks in Muslim countries. Model-M2 measures the efficiency performance of IBB & BBI relative to large Islamic banks in Muslim countries. Model-M3 measures the efficiency performance of BBI relative small conventional banks in BiH. Model-M4 measures the efficiency performance of IBB relative small conventional banks in the UK. However, utilizing data from Model-M1 in the DEA, we measure the relative Malmquist indices of productivity change of IBB and BBI compared with small Islamic banks from Muslim countries. We further make use of Model-M3 and M4 to measure the relative productivity growth of BBI and IBB relative to small conventional banks in both BiH and the UK respectively. ** The column represents the number of the banks in each model.*

Country	Small conventional banks in BiH & the UK
BiH	6
M3: Relative efficiency of BBI compared with small conventional banks in BiH.	
U.K	
M4: Relative efficiency of IBB compared with small conventional banks in the UK.	6
SUM	12

In our paper, we use cross-country bank-level panel data compiled from non-consolidated income statements and balance sheets of 23 Islamic banks in 10 countries. We also derive data from 12 small conventional commercial banks in BiH and the UK, six from each country (Table 1). Our study differs from others in a few key aspects. We first compare the efficiency performance of IBB, *the first British stand-alone full-fledged commercial Islamic bank in the west,* and BBI, *the first Islamic commercial bank in Bosnia and Herzegovina*, against 12 small and 9 large Islamic commercial banks from Muslim-majority countries. We then employ the inter-bank comparison approach to compare the efficiency performance and productivity change of IBB against 6 small conventional banks

[4] The number of banks is reduced mainly due to the exclusion of**:**

i) the new banks that are not older than 5 years ,
ii) all banks other than the commercial banks, and
iii) banks whose financial statements were consolidated with their parent banks

in the UK, and BBI [5] against 6 small conventional banks from BiH respectively. We eventually estimate the cross-country productivity changes of small Islamic commercial banks, both within and outside Europe.

For the purpose of analysis and to analyze the size-efficiency relationship, Islamic banks across the sample are grouped by total assets. Banks with more than 1.5 £ (KM) bn of average total assets (AvTA $_{2005\text{-}2008}$) are categorized as large size, and banks below this level are categorized as small-to-medium size. The time interval 2005-2008 is used to measure the effects of the current global financial crisis on banks efficiency.

3.2. The empirical specifications

3.2.1. *The DEA-Model*

DEA is defined as a linear programming technique that compares multiple outputs and inputs used by firms (DMUs) and generate relative efficiency scores. DMUs with an efficiency score of unity are considered relatively efficient and make up the frontier, while those with a score below unity are relatively inefficient (Berger and Humphrey, 1997). To measure the efficiency of a given DMU, Charnes, et al. (1978) propose the use of the maximum of the ratio of weighted outputs *(y)* to weighted inputs (*x*), subject to the condition that similar ratios for all other DMUs be ≤ 1. For each DMU, efficiency is calculated as follows (Ataullah, Cockerill, and Le, 2004):

$$= \quad max\ e_0 \qquad \sum_{j=1}^{J} w_j^0 y_j^0 / \sum_{i=1}^{I} v_i^0 x_i^0 \tag{1}$$

Subject to:

$$\sum_{j=1}^{J} u_j^0 y_j^n / \sum_{i=1}^{I} v_i^0 x_i^n \leq 1; \quad n = 1, \ldots, N \;\; v_i^0 u_j^0 \geq 0; \quad i = 1, 2 \ldots I; \quad j = 1, 2 \ldots J \tag{2}$$

Where, y_j^n and x_i^n are positive known outputs and inputs of the n_{th} DMU, respectively. The variables v_i^0 and u_j^0 are the variable weights to be determined by solving linear problem 1. The DMU being measured is indicated by the index ‘o’. The optimization is defined for every DMU in the sample such that if the efficiency score e^o= 1, the DMU^o is 100% efficient within the sample. Charnes, Cooper, and Rhodes (1978) transform the above formula into the following linear programming problem (Ataullah, Cockerill, and Le, 2004):

$$max\ h^0 = \qquad \sum_{j=1}^{J} u_j^0 y_j^0 \tag{3}$$

Subject to:

$$\sum_{i=1}^{I} v_i^0 x_i^0 = 1 \qquad \sum_{j=1}^{J} u_j^0 y_j^n - \sum_{i=1}^{I} v_i^0 x_i^n \leq 0; \tag{4}$$

n=1,…, N; $v_i^0 \geq \varepsilon$, $u_j^0 \geq \varepsilon$; i=1, 2,…,I j=1, 2,…,J

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5 BBI claims to be the first Islamic bank in Europe, as it was established on 19 Sep. 2000, 4-years before the IBB was granted a license. However, oldest bank is not necessarily the oldest in history, but the well-developed, the fastest-growing, and the leader in pioneering new and a wide range of financial products and services. Thus, it is generally accepted that the IBB is considered as the first stand-alone full-fledged Islamic commercial bank in the western world. Also, the UK is considered to be the hub of Islamic banking and has the most active and developed Islamic banking sector in Europe which helps the IBB to become more mature compared with BBI. In Bosnia-Herzegovina there is no stock market, and thus BBI cannot emulate the IBB in seeking additional equity finance through having a listing on a local Alternative Investment Market.

Where "**ε**" is an arbitrary small positive number introduced to ensure that all of the known inputs and outputs will have positive weights. When $h^o = 1$, then the DMU^o is efficient; otherwise it is inefficient. However, if inputs are being used ineffectively, then we will have input slack (input-excess), and conversely we will have output slack (output-shortfall). Slack represents the improvements needed to make an inefficient unit become efficient and thus, all input slack and output slack must be equal to zero. These improvements are in the form of an increase/decrease in inputs or outputs. In this paper, we utilize the multi-stage (MS)-DEA methodology (Coelli, 1996), where the outputs from one process can be used as the inputs for the next process, allowing a sequence of radial linear programs in order to identify the efficient projected point for the treatment of slacks. This method is computationally rigorous and more demanding than the one and two-stage methods (Coelli, 1998).

3.2.2. *The DEA -Malmquist Productivity Index -MPI*

There are several different methods that could be used to measure the distance function which make up the Malmquist index.[6] Färe, Grosskopf, Lindgren, and Roos, (1992) construct the DEA-based Malmquist productivity index as the geometric mean of two Malmquist productivity indexes of Caves, Christensen and Diewert, 1982. An important feature of the DEA-Malmquist productivity index is that it can be decomposed into two components: one measuring change in relative technical efficiency (TEch) (how the units being examined have managed to catch-up to the frontier) and the other one measuring change in technology innovation (TECch).

The Malmquist productivity index can be used to identify productivity differences between two firms or one firm over two-time periods (Caves, Cristensen, & Diewert, 1982). Malmquist index numbers can be defined using either the output or the input-oriented approach. This study adopts the output-oriented Malmquist index to measure the contributions from the progress in technology and efficiency change to the growth of productivity in Islamic commercial banks. The output-oriented productivity measures focus on the maximum level of outputs that could be produced using a given input vector and a given production technology relative to the observed level of outputs. This can be achieved using the output distance functions. Caves et al. (1982) show how distance function can be used to define Malmquist indices of productivity change. Färe, Grosskopf, Lindgren, & Roos (1989) show that the output-based Malmquist productivity index between time periods (t) and (t + 1) can be defined as follows (Omar et al. 2006):

$$M_0(x^t, y^t, x^{t+1}, y^{t+1}) = \left[\frac{D_0^t\,(x^{t+1}, y^{t+1})}{D_0^t\,(x^t, y^t)} * \frac{D_0^{t+1}\,(x^{t+1}, y^{t+1})}{D_0^{t+1}\,(x^t, y^t)}\right]^{1/2} \tag{5}$$

Where the notation "$D_0^t\,(x^{t+1}, y^{t+1})$" represents the distance from the period (t+1) observation to the period (t) technology, while (x) and (y) indicate the input and the output, respectively. It measures productivity change from period (t) to period (t+1) using period (t) technology as a benchmark. The second ratio is the period (t+1) Malmquist index and it measures the productivity change from period (t) to period (t+1) using period (t+1) technology as a benchmark. Having a value of (M) greater than one denotes productivity growth (progress or improvement), a value less than one indicates productivity decline (regress or deterioration),while a value of unity corresponds to stagnation (no change). Färe, Shawna, Mary, and Zhongyang (1994) show that the MPI can be decomposed into two components as follows:

$$M_0(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D_0^{t+1}\,(x^{t+1},\ y^{t+1})}{D_0^t\,(x^t, y^t)} * \left[\frac{D_0^t\,(x^{t+1}, y^{t+1})}{D_0^{t+1}\,(x^{t+1},\ y^{t+1})} * \frac{D_0^t\,(x^t,\ y^t)}{D_0^{t+1}\,(x^t, y^t)}\right]^{1/2} \tag{6}$$

The first ratio of Eq. 6 measures the relative technical efficiency changes (TEch) (i.e. movement toward the frontier) from years (t) to (t+1). The second term inside the squared brackets (geome-tric mean of the two ratios) captures the shift in technology or technological changes (TECch) (i.e. shifts in the frontier itself) between the two periods evaluated at (x^t) and (x^{t+1}). Färe et al. (1994) further decompose the technical efficiency change (TEch) component into a pure technical efficiency component and a scale efficiency component as follows:

[6] The Malmquist productivity index (MPI) is often seen as the real driver of growth within an economy. It is used to measure firms' productivity growth. MPI does not require the profit maximization or cost minimization assumption, and information on the input and output prices.

Pure Technical Efficiency Ch. (PTE_{ch}) $= \frac{D_0^t\,(x^t, y^t)}{D_0^{t+1}\,(x^{t+1}, y^{t+1})}$ (7)

Scale Efficiency Ch. (SE_{ch}) = $\left[\frac{D_{oc}^{t+1}\,(x^t,y^t)}{D_0^{t+1}(x^t,y^t)} * \frac{D_0^{t+1}(x^{t+1},Y^{t+1})}{D_{oc}^{t+1}\,(x^{t+1},y^{t+1})} * \frac{D_{oc}^{t}\,(x^t,y^t)}{D_0^{t}(x^t,y^t)} * \frac{D_0^{t}\,(x^{t+1},y^{t+1})}{D_{oc}^{t}(x^{t+1},y^{t+1})}\right]^{1/2}$ (8)

Where $PTE_{ch}*SE_{ch}$ = change in technical efficiency (TEch). PTEch measures the relative ability of the DMUs to convert inputs into outputs. It is defined as the ratio of the own-period distance functions in each period under VRS. SEch, on the other hand, captures changes in the deviation between the VRS and CRS technology. It measures to what extent the DMUs can take advantage of returns to scale by altering its size towards optimal scale (Färe et al. 1994). However, changes in SE may be caused by: **i)** changes in the shape of technology, **ii)** changes in the location of the bank in the input/output space between (t_1) and (t_2), or a combination of **(i)** and **(ii).** While any change in the PTE is caused by a movement of the bank relative to the existing technology (Hassan, 2005).

3.2.3. *The DEA- second-stage analysis : OLS-regression approach*

In order to account for the macroeconomic effects on banking efficiency, we adjust the sample data for differences among countries by deflating all variables using the Consumer Price Index (CPI). We also perform the two-stage method to test the statistical association of the efficiency estimates, obtained from DEA model-1 to model-4, with variables that are neither considered inputs nor outputs and also to determine their influence on the bias-corrected efficiency scores. Thus, after solving for DEA, the efficiency scores are regressed upon the environmental variables which could potentially influence the efficiency of a bank (Sufian and Zulkhibri, 2008).

In the DEA method, the dependent variable has an upper limit of 100%. Therefore, it is a censored variable. If such censoring is the only concern, then Tobit regression could be used. However, we have to deal with biases caused by inefficiency. Consequently, Tobit regression is not valid (Kumbhakar and Lovell, 2000). McDonald (2009) advocates using (OLS) in the DEA 2-stage because it is considered a consistent estimator. In our paper, we examine the following econometric regression model:

E.1: (ξs) = $\alpha + \beta_1 \mathrm{BP}._{jt} + \beta_2\ \mathrm{PER}._{jt} + \beta_3\ \mathrm{LIQ}._{jt} + \beta_4\ \mathrm{LOG.(AS)}_{jt}$
$+\beta_5\ \mathrm{LTA}._{jt} + \beta_6\ \mathrm{DEPO}._{jt} + \beta_7\ \mathrm{IND}._{jt} + \beta_8\ \mathrm{AGE}_{jt}$ (9)
$+\beta_9\ \mathrm{LEV}._{jt} + \beta_{10}\ \mathrm{GDP}_{jt} + \beta_{11}\mathrm{GEO}._{jt} + \varepsilon$

Where the subscript (*j)* refers to a bank, and the subscript (*t)* refers to a sample year. The dependent variable (ξs) is the bank's pure technical efficiency (DEA_{PTE}) which is regressed on a set of common explanatory variables (Table 7- appendix). In this paper, the efficiency of Islamic banks based on binary comparisons is analyzed. Consequently, two regression models (E1 and E2) were basically measured. The first model (E1: model-M1 and model-M2) measures the relative efficiency of IBB and BBI against small and large Islamic banks from Muslim countries, respectively. The second model (E2: model-M3 and model-M4) investigates the relative efficiency performance of the IBB and BBI against small conventional banks in the UK and Bosnia respectively. Empirically, in E2, we replaced the predictor variable (β_{11} $\mathrm{GEO}._{jt}$) by the predictor variable ($\beta_{11}\mathrm{DIVER}_{jt}$). This is basically in order to test if Islamic banks generally enjoy a lower diversification benefit than their conventional counterparts.

4. EMPIRICAL RESULTS

In this section, we first introduce the results pertaining to the efficiency scores (mainly DEA_{PTE} scores because we originally estimate our model under the assumption of DEA-VRS) of IBB and BBI relative to the small and large Islamic banks in Muslim countries and also relative to the small conventional banks in the UK and BiH respectively (Table 2). This is followed directly by the presentation of the results obtained from the comparative analysis of the productivity growth of IBB and BBI relative to small Islamic banks from Muslim-majority countries (Table 3). We then discus the progress in productivity of BBI and IBB relative to a carefully selected sample of conventional banks in BiH (Table 5) and in the UK, respectively (Table 6). Finally, we present the results of the DEA-second stage analysis of efficiency performance.

4.1. Cross-country analysis of banks efficiency performance: DEA-based analysis

Table 2.1 illustrates the DEA-efficiency scores: overall efficiency (Crste), pure technical efficiency (DEA_{PTE}) and scale efficiency (DEA_{SE})) of IBB and BBI relative to small Islamic banks from Muslim-majority countries (model-M1). Results show that both banks have pure technical efficiency scores of less than 1 ($DEA_{PTE}<1$) in each sample year, and thus, are identified as relatively technically inefficient compared to other Islamic banks in model-M1. Results also suggest that, despite being technically inefficient relative to all small Islamic banks from Muslim majority-countries, both, IBB and BBI, exhibit an upward trend in DEA_{PTE} scores. Therefore, they have substantial room for improvements to sustain a competitive edge in the Europe. Overall, it is clear that BBI seems to perform slightly better (closer to the best-practice frontier) than IBB in terms of the average (DEA_{PTE}) (Chart 1-appendix).

Scale efficiency scores for individual banks-(DEA_{SE}) in model-M1 (Table 2.1) show that the IBB experiences a decreasing returns-to-scale (DEA_{DRS}) (so-called diseconomies of scale). This implies that the bank is too large (and has supra-optimum scale size) to take full advantage of scale, and so it should simply shrink certain outputs (i.e. total non-interest bearing loans and total revenues), because we primarily assume an output-oriented model. In contrast, BBI has an increasing return-to-scale (DEA_{IRS}) implying that the bank is too small for its scale of operations and thus operates at sub-optimum scale size. BBI is scale inefficient due to its potential to achieve much higher levels of outputs in BiH. BBI could, however, improve its efficiency by scaling up operations and activities. Results also show that the DEA_{SE} of BBI and IBB is higher than the banks' DEA_{PTE} in all years (e.g. $DEA_{SE\ (BBI\text{-}2005)} = 99.1\% > DEA_{PTE\ (BBI\text{-}2005)} = 24.3\%$, $DEA_{SE\ (BBI\text{-}2006)} = 99.4\% > DEA_{PTE\ (BBI\text{-}2006)} = 34.5\%$, etc.)[7] This demonstrates that the overall technical inefficiency appears to be largely due to pure technical inefficiency rather than scale inefficiency. Based on these results, and due to the fact that the DEA_{PTE} captures the management practices while the DEA_{SE} reveals whether or not the bank operates under optimal size, it seems that the banks inefficiencies are mostly due to poor management.

In comparison with large Islamic banks in model-M2 (Table 2.2), BBI shows efficient performance in the first two years ($DEA_{PTE\ (2005\text{-}2006)} = 1$) despite its small size. The bank's efficiency scores gradually decreased over time until it became inefficient throughout 2007-2008 ($DEA_{PTE\ (2007\text{-}2008)} < 1$). Surprisingly, BBI is slightly better able to operate closer to its efficient frontier than IBB (Chart 2- appendix). However, unlike BBI, IBB shows an overall upward trend of DEA_{PTE} scores over the sample period (e.g. $DEA_{PTE\ (2006)} = 65.8\%$, $DEA_{PTE\ (2007)} = 70\%$, and $DEA_{PTE\ (2008)} = 86.9\%$). By and large, both banks report a low DEA_{SE} compared to DEA_{PTE} and consistently achieve a DEA_{IRS} over the sample period. Such results imply that they suffer most from the non-optimal level (size) of operations.

We measure the comparative efficiency scores of BBI versus small conventional banks in BiH banking industry in model-M3 (Table 2.3 and Chart 3- appendix). Results confirm the previous findings and show that the bank is, by and large, inefficient and its mean performance is at the lower end of the spectrum of small banks. BBI operates at increasing returns to scale (DEA_{IRS}), suggesting that the bank is relatively small compared to its counterparties-conventional banks. Meanwhile, the bank's DEA_{PTE} is higher than DEA_{SE} and thus, its overall inefficiency appears to be mostly due to scale (size of banks operation) rather than pure technical inefficiency (management practices).

Similarly, we measure the comparative efficiency scores of IBB against small conventional banks in the UK in model-M4 (Table 2.4 and Chart 4-appendix). Results reveal that IBB fails again to appear on the efficiency

[7] Secondarily, in order to further extend the explanation of results concerning the efficiency performance of Islamic banks in Europe, results from Table 2.1 also illustrates that the Islamic banks from Turkey (geographically speaking, Turkey belongs to Europe) achieve efficiency scores of less than 1 over the first 3-years. In contrast, in 2008, they become increasingly more efficient. The DEA_{PTE} for these banks is, on average, higher than DEA_{SE} consequently, bank's inefficiency was attributed largely to scale inefficiency and to a lesser extent to the pure technical inefficiency. However, our analysis shows that the Turkish Islamic banks are more efficient than BBI and IBB. For example in 2005, the DEA_{PTE} for IBB and BBI is 30.7% and 24.3% compared to 76.1% and 89.3% for Albaraka Turk bank and Kuveyt Turk bank, respectively. Turkish Islamic banks record a DEA_{DRS} over the sample years. This indicates that they could improve their own efficiency by scaling down activities because they are too large for the volume of operations they conduct.

frontier over the years 2006-08, and hence is identified as inefficient. In contrast to BBI, IBB operates at a DEA_{DRS} (diseconomies of scale-too high scale of operation) throughout the sample period. Meanwhile, pure technical (in)efficiency dominates scale (in)efficiency (SE_{05-08}>PTE_{05-08}). Based on that, IBB is said to be technically inefficient largely due to "bad" management and to some extent because of the non-optimal size of operations.

Overall, results from model-M1, M2, M3, and M4 show that the DEA_{PTE} of large Islamic banks from Muslim-majority countries is, on average, on a declining trend from 2005 to 2008. On contrary, IBB experiences a trend of increasing efficiency relative to other Islamic banks (small and large) over the period 2006-2008 but records a negative trend of efficiency performance levels as compared to conventional banks in the UK. Meanwhile, BBI suffers a decline in estimated efficiency during 2007 and 2008, strikingly though, at a low rate compared with most of its conventional-counterparts in BiH, and Islamic banks (particularly the large banks) in Muslim countries. This, however, reflects a smaller impact of the global financial crisis of 2007-2008 on small Islamic banks, either from Muslim countries or from Europe. This also suggests that they can provide certain services better and more efficiently than their counterparties-conventional banks and the large Islamic banks from GCC-States, Malaysia, and Turkey.[8]

4.2. Cross-country analysis of banks productivity growth: DEA-based MPI analysis

In this section, we focus on productivity changes with respect to the 14 small Islamic banks operating within and outside Europe (model-M1). Tables 3.1 to 3.3 report the estimated values of the Malmquist-based total factor productivity (TFP) index, along with its two subcomponents: changes in technical efficiency (TEch) and changes in technological efficiency (TECch). Subtracting 1 from the reported results yields an average percentage increase or decrease per annum.

Table 3.1 shows that the Islamic banking sector, within and outside Europe, exhibits a decreasing trend in the relative TFP growth over the sample period, with a mean TFP of 106.3% in 2005-06, 96.5% in 2006-07, and 95.1% in 2007-08. In contrast, both IBB and BBI yield positive growth until 2006-07, but the trend reverses in 2007-08. Overall, results illustrate an inefficient performance of the entire Islamic banking sector, with a mean TFPch of 99.3% (indicating 0.7% decline in TFP). By specifically analyzing the efficiency performance of "old" versus "new" banks, [9] findings suggest that some large banks from Muslim countries, such as Albaraka Turk, Kuveyet Turk, and QIIB, have been able to achieve a positive productivity growth TFPch of 4%, 1.4%, and 7.7%, respectively. Strikingly, some of the newer banks, particularly from Europe, achieved a much higher TFP growth. For example, BBI exhibits an average increase (growth) of 24.8% in $TFP_{2005-08}$ mainly due to high average growth rate (progress) of 2.9% (Table 3.2) in technological efficiency (TECch). This suggests that the desirable increase in TFP of the BBI should be primarily based on technology innovation rather than the improvement in technical effciency. However, IBB, in contrast, produces an average decline (negative growth) of $TFP_{2005-08}$ = -3.6% (calculated as 1 – 96.4%) driven mostly by the significant regress of 29.8% (calculated as 1 – 70.2%) in the bank's TECch (Table 3.2).

Table 3.2 presents the index values of technological progress/regress as measured by average shifts in the best-practice frontier from period (t) to (t+1). Results show an overall downward trend in the Islamic banking sector's technological (innovation) efficiency (TECch) throughout the sample years (i.e. 15% in 2005-06,-6.8% in 2006-07, and -10.5% in 2007-08). The sector suffers, however, an average regress of -0.8% (calculated as 1-99.2%) in TEC over sample years. Large portion of the productivity regression in 2007-08 was caused by Islamic banks from Muslim countries. Islamic banks from the UK, BiH and Turkey accounted for a relatively small amount of the

[8] Our analysis shows that Kauther bank is a special case. It is efficient because it receives unit efficiency scores over the sample years in model-M1. But because the bank has the smallest inputs and outputs, it has no peers to which it can be compared, and thus, it is considered as efficient 'by default'. All other banks in our sample have comparable units except Kauther bank. The bank is self-identified as 100% efficient not because it dominates other banks but because there are no other banks with which it is comparable. This, however, indicates that Kauther bank is not truly (should not be regarded) efficient relative to other banks in the sample.

[9] The bank's age is calculated from the date of incorporation until the 1st of 2010. For the purpose of our study, banks that are not older than 10 years (Age ≤10 years) are considered new. Otherwise, they are considered as old banks.

aggregate technological inefficiency. For example, while many banks show a negative TECch growth in 2007-08, BBI and IBB show an upward trend in TECch, proving their ability to get closer to the productivity frontier with high TECch scores of 95.4% and 92.8% respectively.

Table 3.3 displays changes in the relative technical efficiency (TEch) for each individual bank. Results show a considerable variation across banks and years. On average, BBI is relatively technically efficient with mean score of 1. Kauther bank records the highest efficiency change of 16.7%, followed directly by IBB with average efficiency scores of 15.3%. Such results illustrate that the Islamic banks from Europe perform relatively better than some of those operating in Muslim-majority countries despite the legal obstacles and economic restrictions, such as the conventional banking regulations and the lack of uniform standards of credit analysis, which may put these banks in a challenging situation. This could be due to the fact that the Islamic banks from Muslim countries, either small or large, are relatively larger (in terms of total asset) than Islamic banks that are operating in Europe. Therefore, they tend to engage in more complex Islamic-compatible products and services, which could negatively affect the banks' relative efficiency levels. Overall, findings show that the Islamic banking sector has been in a downward trend in technical efficiency from 2005-07 but, surprisingly, shows a quick recovery in 2007-08 despite the global financial and economic crisis which commenced in 2007.

Table 3.4 presents the decomposition of the technical efficiency change into two subcomponents namely: pure technical efficiency change (PTEch) and scale efficiency change (SEch). The table clearly shows that the PTEch is higher than the SEch in 2005-06 and 2006-07. This implies that the technical inefficiency change for the Islamic banking sector is primarily driven by scale inefficiency (non-optimal size of operations). In contrast, SEch is higher than PTEch in 2007-08, which suggests that the technical inefficiency in Islamic banks, as they become mature, is more than likely due to the managerial factors, such as shortage of Islamic finance expertise versed in Shari'ah law. Overall, it seems that the growth in TFP for Islamic banking sector is largely contributed by PTEch rather than SEch (average SEch=99.1% < average PTEch=106.3%). This indicates that the size of the bank does matter in affecting productivity changes and implies that the banks future growth in TFP could be based on the size of the bank's operations.

4.3. Inter-bank analysis of banks productivity growth: DEA-based MPI analysis

4.3.1. *The banking industry in Bosnia and Herzegovina*

The results in Table 5.1 show that the BBI records the highest value in total factor productivity growth (TFPch) for 2005-06 relative to all counterparties-conventional banks. But it gradually loses its superiority over other banks and is unable to maintain its number one position in subsequent years. Overall, the bank still retains the highest mean TFPch over sample years.

Concerning the analysis of banks TECch (Table 5.2), findings suggest that all conventional banks in BiH experience both technology progress and regress. Surprisingly, BBI consistently exhibits a technology progress during the sample period. More specifically, BBI records a positive growth of 5.2% in 2005-06, 22.3% in 2006-07 and 7.4% in 2007-08. BBI records also an average growth rate of 11.6% (1.116 -1) compared with an average TECch of 8.1% (calculated as: (1+1.1+1.307+1.022+1.128+0.927)/6) attained by (all) counterparties-conventional banks. These results, however, suggest that the high factor productivity growth achieved by average banks in Bosnia's banking sector, including the BBI, as observed in (Table 5.1) is largely attributed to the technological efficiency rather than technical efficiency.

Table 5.3 reports the changes in banks' relative technical efficiency (TEch) while Table 5.4 reports the changes in the components of technical efficiency (PTEch and SEch). Results in Table 5.3 show that the overall Bosnia's banking industry, as well as BBI, suffers a clear declining trend in estimated TEch from 2005 to 2008 (i.e. $TEch_{sector\ 05\text{-}06}$=109% > $TEch_{sector\ 06\text{-}07}$= 101.6% > $TEch_{sector\ 07\text{-}08}$= 98.5% meanwhile, $TEch_{BBI\ 05\text{-}06}$=120.6% > $TEch_{BBI\ 06\text{-}07}$= 102.3% > $TEch_{BBI\ 07\text{-}08}$= 94.3%). As far as the full sample period is concerned, BBI records, on average, the third-highest mean TEch of 5.7% as compared to counterparties-conventional banks. This suggests that BBI has made relatively better technical progress than some of conventional banks having the same economic circumstances and similar size.

Results in Table 5.4 show that the mean PTE_{ch} of banks in BiH is less than the mean SEch throughout 2005-2007. In 2007-2008 the mean PTEch becomes higher than the mean SEch. Similarly, at the individual bank level, the PTEch for BBI trends up over the years 2005-2008 and eventually outperforms SEch in 2007-08 ($SEch_{07-08}$ =94.3 < $PTEch_{07-08}$ =1). These results indicate that the PTEch (improvements in management practices) appears to be a less important source of future growth of technical efficiency as compared to the optimal size component.

Overall, findings show that the highest growth in mean TFP, TECch, and TEch was achieved by banks other than the BBI. This growth was largely driven by banks' optimal scale of operations. The relative superiority of (some) conventional banks over BBI may re-emphasize the important role of the conventional economic restrictions and the lack of legal support and effective prudential regulations on affecting the efficiency performance of Islamic banks in BiH.

4.3.2. *The banking industry in the UK*

Table 6.1 shows that the IBB records an upward trend in TFP over the sample years (i.e. 78.4% in 2005-06, 90.6% in 2006-07, and 93.4% in 2007-08). Despite this positive trend, the bank suffers the highest average TFP deterioration of -12.5% (calculated as 1 - 87.5%) over 2005-2008 relative to counterparties banks. In contrast, the average counterparties-conventional banks produce positive growth of 4.2% (calculated as: 1 (1.009+1.058+1.009+0.998+1.162+1.014) /6) for the same time interval.

In terms of the relative technological change (TECch), results in Table 6.2 show an increasing growth rate in technological innovations for average conventional banks over the period 2005-2007 (i.e. from 118.2% in 2005-2006 to 128.1% in 2006-2007, calculations do not include IBB) but reveal also a sudden decrease in TEC growth rates during the adverse economic conditions in 2007-08 with a TECch =126.3%. In contrast, IBB individually exhibits a strong and consistent upward trend in the average TECch over the sample years (i.e. $TECch_{-05-06}$ =78.4% and $TECch_{06-07}$ =90.6%) and also, surprisingly, it becomes technologically efficient with a TECch= 100.8% in 2007-2008. Such results confirm that the Islamic banking in the UK has a strong long-term potential for further growth in technology innovation in spite of the economic downturns.

Table 6.3 presents the findings related to banks relative technical efficiency (TEch). Overall, results illustrate that the entire UK banking sector (Islamic and conventional) experiences a gradual decrease in technical efficiency (i.e. from 102.2% in 2005-06 to 101.03% and 97.4% in 2006-07 and 2007-08 respectively). More specifically, IBB suffers a sharp decline of 7.3% (calculated as: 1- 92.7%) in the technical efficiency performance in 2007-08 after two years of good and consistent performance. By and large, results clearly illustrate that the IBB is still nascent and lagging behind its counterparties-conventional banks in the UK financial system with an overall mean TEch of -2.4% (calculated as: 1- 97.6%).

Table 6.4 summarizes the changes in the two components of bank's technical efficiency in the UK. The UK conventional banks, on average, have a low SEch relative to its PTEch (i.e. $PTEch_{05-08}$ =100.9% > $SEch_{05-08}$ =99.9%, IBB is excluded from calculation), indicating that the sector‘s technical inefficiency is largely scale in nature rather than managerial. In contrast, IBB records the highest deterioration of – 6.9% (1- 93.1%) in PTE in 2007 and 2008. It also records a low deterioration rate of -0.5% (1- 99.5%) in SE for the same period. This suggests that the size of IBB operations appears to be less important source to further technical efficiency growth as compared to the PTEch, which is primary driver of the IBB inefficient performance.

Overall, results suggest that the average growth of 1.8% in TFPch (Table 6.1), 1.6% in TECch (Table 6.2), and 0.30% in TEch (Table 6.3) in the UK banking sector (conventional and Islamic) is more likely due to management efforts rather than the scale component. More specifically, on average, IBB records the lowest average growth of –12.5% in TFPch, which is driven mainly by the bank‘s average technological (TECch) regress of –10.1%. However, the TEch contribution to the bank‘s low growth in TFPch is relatively minor.

4.4. Adjustment to the environmental differences: OLS-regression results

The second-stage DEA analysis reveals a different set of findings. In contrast to the DEA-efficiency results, which suggest that the bank size has no significant predictable effect on its efficiency, the second- stage DEA analysis shows that the bank size has a significant positive relationship with DEA_{PTE} efficiency scores, in model -M2, (t = 2.743, p = 0.05). [10, 11] This indicates that the larger Islamic banks have inevitably higher DEA_{PTE}. The large size promotes technical efficiency by inducing economies of scale to reduce average total costs. Large size is also anticipated to enable banks to be more diversified in an uncertain macroeconomic environment, to mobilize more funds and hence generate high returns to its depositors, and to finance a large number of profitable investment opportunities.

In testing the relationship between leverage and efficiency performance, we find a significant positive relationship in model-M3 (small conventional banks) with (t = 1.856, p < 0.10). This illustrates that small conventional banks with high levels of leverage are more efficient. A high leverage or a low capital adequacy reduces the agency cost and increases a bank's efficiency. Thus, the high performing banks acquire more debt (Ross, 1977). The leverage also allows small banks to make a lot of safer loans and therefore plenty of investment returns.

Another important finding is the regression coefficient between the obtained DEA scores and the financial ratios (ROA and ROE). Interestingly, the analysis reveals a statistically significant [1212] relationship between the variables in model-M1 (t = 2.243, p < 0.05), in model-M2 (t = 2.437, p < 0.05), and in model-M3 (t = 2.089, p < 0.10). Findings illustrate that the more profitable Islamic (small and large) and conventional banks are more efficient. Such results suggest that the various measures of efficiency are strongly associated with the traditional accounting measures of performance, which are always considered as useful tool for comparing one bank against another, and hence are robust and not 'valueless' artifacts of our advanced techniques.

To assess the effects of the skills utilization on the bank's efficiency, we use the human management as proxy. Results show a statistically significant relationship between efficiency scores and staff utilization variables in model-M2 (t = 7.939, p<0.001). The results suggest a strong link between increased investment in skills and the positive efficiency trends in the large Islamic banks. In contrast, the same explanatory variable does not have a significant influence on promoting efficiency for conventional banks.

The proxy for economic conditions (GDP) displays a positive and significant relationship with DEA_{PTE} in model-M1 (t = 2.257, p < 0.05), and in model-M2 (t = 2.239, p < 0.05). Such a result indicates that the favorable macroeconomic conditions seem to stimulate higher efficiency. This is due to the fact that the excessive demand for Islamic financial services tends to grow as economies expand.

To control for the effects of the geographical region on banks' efficiency, the predictor (GEO.) is used. Results suggest that small Islamic banks from Europe exhibit a much better performance compared with large Islamic banks operating in Muslim countries (t = 2.138, p<0.05-model-M2) in spite of the restrictions and conventional regulations in the UK banking industry. It is significantly more complex for Islamic banks to adjust their credit risk monitoring system as they become bigger. Large banks tend to engage in more PLS arrangements compared to small banks, and thus, monitoring schemes becomes more diverse, which could consequently reduce banks efficiency (Čihák and Hesse, 2008).

To capture the effects of liquidity and the absence of an international inter-bank money market for Islamic banks on their overall efficiency, the independent variable (liquidity) is used. Results reveal a significant negative relationship between the liquidity predictor and the DEA_{PTE} in the context of conventional banking system in model-M3 (t=-1.891, p<0.10). This indicates that conventional banks that accumulate a significant amount of liquid

[10] In practice, the application of both regression and DEA on the same data set often produces strikingly different efficiency results, particularly in the small samples which are prevalent in regulated industries (Cubbins, and Tzanikadis, 1998).

[11] If $\alpha = 0.05$ and If $p \leq 0.05$, we reject the null hypothesis and accept the alternative hypothesis.

[12] Because of the high correlation between ROA and ROE (M1: r= 0.795, M2: r=0.933, and M3: r=0.837), the later measure was dropped from the analysis.

resources have inefficient performance. In the context of Islamic banks, the analysis fails to find significant relationship between liquidity and DEA_{PTE} in model-M1 and model-M2.

Results regarding the effects of banks 'diversification on the DEA_{PTE} scores reveal insignificant inverse relationship. It appears that there is no significant difference between Islamic and conventional banks in term of product diversity. This finding, nevertheless, does not support the prevailing belief that Islamic banks generally enjoy a lower diversification benefit than their conventional counterparts because they enjoy limited set of investments opportunities due to the Shari'ah restrictions.

Additionally, with regard to the impact of the age of a bank on efficiency, results show insignificant negative coefficients in all models. This suggests that new banks can be as efficient as old banks. However, the negative direction in the relationship between the two variables suggests that older banks are not necessarily flexible enough to make the rapid adjustments to changing circumstances as opposed to new banks which are considered more entrepreneurial.

In order to estimate the effects of the bank's market share on efficiency, we use the bank‘s de-posits as a proxy. Results reveal a statistically insignificant negative relationship between the two variables. The insignificant correlation between the two variables, theoretically, suggests that the more efficient banks may have either a lower or higher market share, implying that banks with small market share can be at least as efficient as the market prominent banks are.

The proxy of bank‘s loans intensity shows a statistically insignificant positive relationship with DEA_{PTE}. This illustrates that small banks with higher loans-to-assets ratios might have either higher or lower efficiency scores. As a result, small banks' loans seem not to be valued more than alternative banks outputs. Eventually, the estimation of the lack of independency factor that is used to capture the impact of a bank's dependency on its efficiency reveals an insignificant relationship with DEA_{PTE}. This indicates that there is no evidence that a bank's independence is related to high efficiency.

5. CONCLUSIONS

Based on DEA-efficiency scores, our findings suggest that the Islamic Bank of Britain (IBB) and Bosna Bank International (BBI) are technically inefficient compared to small and large Islamic banks in Muslim countries and small conventional banks in the UK and Bosnia (BiH) respectively. Banks' inefficiency, by and large, stems from inefficient *management* compared with small Islamic banks. In comparison with large Islamic banks, the relative inefficiency of IBB and BBI becomes rather scale in nature. In comparison with small conventional banks, the non-optimal size of operations becomes more significant to explain the relative inefficiency of BBI, but in case of IBB the poor management plays more considerable impact on its inefficiency.

Our findings indicate that the BBI displays, despite its inefficiency, higher average efficiency scores than IBB, and thus is better able to operate closer to the efficient frontier. IBB, in contrast to BBI, exhibits not only lower efficiency scores, but also unstable trends in its overall performance. Specifically, while the bank provides a strong growth potential by recording a sustained upward trend in estimated efficiency as compared with other Islamic banks, it strikingly, shows a negative trend in efficiency levels over the sample period as compared with conventional banks.

Results pertaining to the Malmquist Productivity Index indicate that the BBI yields a positive growth in total factor productivity, mainly due to the progress in technical efficiency. The bank also achieves an impressive technological-(innovation) progress. This trend subsequently reverses, apparently because of the adverse market conditions. In contrast, IBB, as well as Islamic banking sector, suffers a negative growth in total factor productivity, driven, to a large extent, by the regress in banks' innovation. Findings further reveal that, in contrast to the entire Islamic banking sector, both, IBB and BBI, experience a remarkable growth in technical efficiency prior to the 2007 crisis, but they are exposed to a significant decline after the emergence of the crisis, primarily due to a lack of management skills. Nevertheless, on average, IBB and BBI produce overall better substantial growth in technical efficiency compared to some other Islamic banks.

In comparison with conventional banks in the BiH banking sector, BBI gradually loses its superiority in both total factor productivity and technical efficiency, but still retains a high mean growth rate in both indices over the years. Overall, the improvements in management practices appear to be a less important source for further growth in the BBI's technical efficiency as compared to the optimal size component. Moreover, compared to conventional banks in the UK, IBB records higher average deterioration in total factor productivity growth driven by the bank's average (mean values at the end of 4-sample years) innovation regress. However, a continuing upward trend is found in the IBB's innovation over time. In terms of technical efficiency changes, IBB is lagging behind its counterparties banks, mainly due to inferior management.

In terms of the DEA-second stage analysis, findings illustrate that the more efficient Islamic banks are larger in size, have greater profit potential, acquire lower levels of debt and have increased investment in required skills. Furthermore, a more efficient use of banks resources is highly associated with a higher GDP-per capita.

AUTHORS INFORMATION

Ahmad M. Abu-Alkheil, Ph.D. Student, University of Hohenheim - Schloss, Germany. PhD Candidate in Finance; E-mail: ahmad_abualkheil@yahoo.co.uk

Hans-Peter Burghof, Ph.D., University of Hohenheim - Schloss, Germany. Professor of Finance and chair of the Banking and Finance department; E-mail: burghof@uni-hohenheim.de

Walayet A. Khan, Ph.D., University of Evansville, USA. Professor of Finance; E-mail: wk3@evansville.edu (Corresponding author)

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APPENDIX

Table 2
DEA-efficiency scores: IBB & BBI relative to Islamic banks in Muslim countries and conventional banks in the UK & BiH

Table 2.1
DEA-Efficiency scores: IBB & BBI in comparison with small Islamic banks from Muslim countries (Model-M1)

Year	Country	The Bank	crste	vrste	scale	rts(*)
2005	B iH	BBI	0.241	0.243	0.991	irs
2005	U.K	IBB	0.307	0.307	0.999	-
2005	Azerbaijan	Kauther bank	0.347	1.000	0.347	irs
2005	Qatar	Qatar International Islamic Bank	0.695	1.000	0.695	drs
2005	Bahrain	Khaleeji Commercial Bank	1.000	1.000	1.000	-
2005	Bahrain	Bahrain Islamic Bank	1.000	1.000	1.000	-
2005	Bahrain	Shamil Bank	0.453	0.497	0.912	drs
2005	Bahrain	Abc Islamic Bank	1.000	1.000	1.000	-
2005	U.A.E	Sharjah Islamic Bank	0.975	1.000	0.975	drs
2005	Malaysia	RHB	0.790	0.790	1.000	-
2005	Malaysia	CIMB	0.055	0.055	0.998	-
2005	Turkey	Albaraka Turk	0.621	0.761	0.816	drs
2005	Turkey	Kuveyt Turk	0.626	0.893	0.702	drs
2005	Kwuait	Boubyan Bank	0.893	0.898	0.994	drs
2006	BiH	BBI	0.343	0.345	0.994	irs
2006	U.K	IBB	0.285	0.306	0.931	drs
2006	Azerbaijan	Kauther bank	0.645	1.000	0.645	irs
2006	Qatar	Qatar International Islamic Bank	1.000	1.000	1.000	-
2006	Bahrain	Khaleeji Commercial Bank	0.985	0.986	0.999	irs
2006	Bahrain	Bahrain Islamic Bank	0.596	0.596	0.999	-
2006	Bahrain	Shamil Bank	0.591	0.625	0.946	drs
2006	Bahrain	Abc Islamic Bank	1.000	1.000	1.000	-
2006	U.A.E	Sharjah Islamic Bank	0.837	0.926	0.904	drs
2006	Malaysia	RHB	0.889	1.000	0.889	drs
2006	Malaysia	CIMB	0.629	0.632	0.996	irs
2006	Turkey	Albaraka Turk	0.657	0.820	0.801	drs
2006	Turkey	Kuveyt Turk	0.691	0.986	0.701	drs
2006	Kwuait	Boubyan Bank	0.806	0.841	0.959	drs
2007	BiH	BBI	0.483	0.485	0.996	irs
2007	U.K	IBB	0.369	0.381	0.968	drs
2007	Azerbaijan	Kauther bank	1.000	1.000	1.000	-
2007	Qatar	Qatar International Islamic Bank	1.000	1.000	1.000	-
2007	Bahrain	Khaleeji Commercial Bank	1.000	1.000	1.000	-
2007	Bahrain	Bahrain Islamic Bank	0.635	0.671	0.947	drs
2007	Bahrain	Shamil Bank	0.658	0.706	0.932	drs
2007	Bahrain	Abc Islamic Bank	1.000	1.000	1.000	-
2007	U.A.E	Sharjah Islamic Bank	0.761	0.879	0.866	drs
2007	Malaysia	RHB	0.612	0.845	0.724	drs
2007	Malaysia	CIMB	0.246	0.355	0.692	drs
2007	Turkey	Albaraka Turk	0.646	0.934	0.691	drs
2007	Turkey	Kuveyt Turk	0.629	0.948	0.663	drs
2007	Kwuait	Boubyan Bank	0.721	0.858	0.840	drs
2008	BiH	BBI	0.438	0.439	0.998	irs
2008	U.K	IBB	0.397	0.401	0.990	drs
2008	Azerbaijan	Kauther bank	0.918	1.000	0.918	irs
2008	Qatar	Qatar International Islamic Bank	0.871	1.000	0.871	drs
2008	Bahrain	Khaleeji Commercial Bank	0.852	1.000	0.852	drs
2008	Bahrain	Bahrain Islamic Bank	0.522	0.758	0.689	drs
2008	Bahrain	Shamil Bank	0.811	1.000	0.811	drs
2008	Bahrain	Abc Islamic Bank	1.000	1.000	1.000	-
2008	U.A.E	Sharjah Islamic Bank	0.820	1.000	0.820	drs
2008	Malaysia	RHB	0.585	0.863	0.678	drs
2008	Malaysia	CIMB	0.549	1.000	0.549	drs
2008	Turkey	Albaraka Turk	0.675	1.000	0.675	drs
2008	Turkey	Kuveyt Turk	0.626	1.000	0.626	drs
2008	Kwuait	Boubyan Bank	0.671	0.981	0.684	drs

**(Crst)e= Overall (total) efficiency scores, (Vrste)=Pure technical efficiency scores (Scale)=Scale efficiency, and (rts)=return to scale.*

Table 2.2
DEA-Efficiency scores: IBB & BBI in comparison with large Islamic banks from Muslim countries (Model-M2).

Year	Country	The Bank	crste	vrste	scale	rts
2005	BiH	BBI	0.329	1.000	0.329	irs
2005	U.K	IBB	0.326	1.000	0.326	irs
2005	Qatar	Qatar Islamic Bank	0.969	0.982	0.986	irs
2005	Kuwait	Kuwait Finance House	0.848	0.880	0.963	drs
2005	Bahrain	Albaraka Islamic bank	0.512	0.514	0.998	irs
2005	K.S.A	Bank Albilad	0.691	0.717	0.963	irs
2005	K.S.A	Al Rajhi Bank	1.000	1.000	1.000	-
2005	K.S.A	Aljazira	0.715	0.736	0.971	drs
2005	U.A,E	Emirates Islamic Bank	0.771	0.822	0.937	irs
2005	U.A.E	DIB	1.000	1.000	1.000	-
2005	Malaysia	Bank Islam	0.682	0.691	0.987	irs
2006	BiH	BBI	0.379	1.000	0.379	irs
2006	U.K	IBB	0.321	0.658	0.488	irs
2006	Qatar	Qatar Islamic Bank	1.000	1.000	1.000	-
2006	Kuwait	Kuwait Finance House	0.741	0.816	0.908	drs
2006	Bahrain	Albaraka Islamic bank	0.590	0.591	0.998	irs
2006	K.S.A	Bank Albilad	0.512	0.518	0.989	irs
2006	K.S.A	Al Rajhi Bank	1.000	1.000	1.000	-
2006	K.S.A	Aljazira	1.000	1.000	1.000	-
2006	U.A,E	Emirates Islamic Bank	0.814	0.837	0.973	irs
2006	U.A.E	DIB	0.882	0.914	0.966	drs
2006	Malaysia	Bank Islam	0.513	0.520	0.988	irs
2007	BiH	BBI	0.471	0.854	0.552	irs
2007	U.K	IBB	0.360	0.700	0.515	irs
2007	Qatar	Qatar Islamic Bank	0.956	0.966	0.989	irs
2007	Kuwait	Kuwait Finance House	0.969	1.000	0.969	drs
2007	Bahrain	Albaraka Islamic bank	0.641	0.648	0.989	drs
2007	K.S.A	Bank Albilad	0.469	0.472	0.994	irs
2007	K.S.A	Al Rajhi Bank	1.000	1.000	1.000	-
2007	K.S.A	Aljazira	0.448	0.487	0.920	drs
2007	U.A,E	Emirates Islamic Bank	0.774	0.787	0.984	irs
2007	U.A.E	DIB	0.831	0.854	0.973	drs
2007	Malaysia	Bank Islam	0.468	0.472	0.992	irs
2008	BiH	BBI	0.475	0.646	0.736	irs
2008	U.K	IBB	0.394	0.869	0.453	irs
2008	Qatar	Qatar Islamic Bank	1.000	1.000	1.000	-
2008	Kuwait	Kuwait Finance House	0.834	1.000	0.834	drs
2008	Bahrain	Albaraka Islamic bank	0.592	0.618	0.958	drs
2008	K.S.A	Bank Albilad	0.460	0.461	0.996	irs
2008	K.S.A	Al Rajhi Bank	0.918	1.000	0.918	drs
2008	K.S.A	Aljazira	0.400	0.401	0.998	irs
2008	U.A,E	Emirates Islamic Bank	0.824	0.826	0.998	irs
2008	U.A.E	DIB	0.665	0.667	0.996	drs
2008	Malaysia	Bank Islam	0.450	0.452	0.996	irs

Table 2.3
DEA efficiency scores: (BBI) relative to small conventional banks in BiH (Model-M3)

Year	The bank	crste	vrste	scale	rts
2005	BBI	0.559	0.776	0.719	irs
2005	VAKUFSKA BANKA	0.647	0.780	0.829	irs
2005	ABS BANKA DD SARAJEVO	0.619	0.737	0.840	drs
2005	Investiciono-komercijalna	0.501	1.000	0.501	irs
2005	ProCredit Bank	0.818	1.000	0.818	drs
2005	Balkan Investment bank	0.993	1.000	0.993	irs
2005	Turkish Ziraat Bank Bosnia d.d.	1.000	1.000	1.000	-
2006	BBI	0.705	1.000	0.705	irs
2006	VAKUFSKA BANKA	0.565	0.645	0.875	irs
2006	ABS BANKA DD SARAJEVO	0.678	0.809	0.838	drs
2006	Investiciono-komercijalna	0.612	1.000	0.612	irs
2006	ProCredit Bank	0.768	1.000	0.768	drs
2006	Balkan Investment bank	0.823	0.963	0.854	irs
2006	Turkish Ziraat Bank Bosnia d.d.	1.000	1.000	1.000	-
2007	BBI	0.886	1.000	0.886	irs
2007	VAKUFSKA BANKA	0.653	0.716	0.912	irs
2007	ABS BANKA DD SARAJEVO	0.879	1.000	0.879	drs
2007	Investiciono-komercijalna	0.782	1.000	0.782	irs
2007	ProCredit Bank	0.699	1.000	0.699	drs
2007	Balkan Investment bank	1.000	1.000	1.000	-
2007	Turkish Ziraat Bank Bosnia d.d.	0.667	0.700	0.952	drs
2008	BBI	0.908	0.976	0.930	irs
2008	VAKUFSKA BANKA	0.841	0.894	0.941	irs
2008	ABS BANKA DD SARAJEVO	1.000	1.000	1.000	-
2008	Investiciono-komercijalna	1.000	1.000	1.000	-
2008	ProCredit Bank	0.623	1.000	0.623	drs
2008	Balkan Investment bank	1.000	1.000	1.000	-
2008	Turkish Ziraat Bank Bosnia d.d.	0.984	0.984	1.000	-

Table 2.4
DEA efficiency scores: (IBB) relative to small conventional banks in UK (Model-M4)

Year	The bank	crste	vrste	scale	rts
2005	IBB	1.000	1.000	1.000	-
2005	Turkish Bank (UK)	0.893	0.916	0.975	irs
2005	ICBC London Limited	1.000	1.000	1.000	-
2005	Habib Allied INT. Bank	0.873	0.905	0.966	drs
2005	Ghana INT. Bnak	1.000	1.000	1.000	-
2005	Bank of Beirut(UK)Ltd	0.964	1.000	0.964	irs
2005	Bank Leumi UK	0.896	0.993	0.902	drs
2006	IBB	0.825	0.901	0.916	drs
2006	Turkish Bank (UK)	0.860	0.878	0.980	irs
2006	ICBC London Limited	0.990	1.000	0.990	irs
2006	Habib Allied INT.	0.906	0.948	0.955	drs
2006	Ghana INT. Bnak	1.000	1.000	1.000	-
2006	Bank of Beirut(UK)Ltd	0.670	0.899	0.746	irs
2006	Bank Leumi UK	0.949	1.000	0.949	drs
2007	IBB	0.815	0.898	0.908	drs
2007	Turkish Bank (UK)	0.860	0.860	1.000	-
2007	ICBC London Limited	1.000	1.000	1.000	-
2007	Habib Allied INT. Bank	0.938	0.978	0.959	drs
2007	Ghana INT. Bnak	1.000	1.000	1.000	-
2007	Bank of Beirut(UK)Ltd	0.774	0.847	0.913	irs
2007	Bank Leumi UK	0.964	1.000	0.964	drs
2008	IBB	0.789	0.856	0.922	drs
2008	Turkish Bank (UK)	0.947	0.997	0.949	irs
2008	ICBC London Limited	1.000	1.000	1.000	-
2008	Habib Allied INT. Bank	0.938	0.977	0.960	drs
2008	Ghana INT. Bnak	0.884	1.000	0.884	drs
2008	Bank of Beirut(UK)Ltd	1.000	1.000	1.000	-
2008	Bank Leumi UK	0.973	1.000	0.973	drs

APPENDIX Table 3: MPI-Productivity growth: IBB & BBI in comparison to small Islamic banks in Muslim countries and in Europe.*

Table 3.1
Banks Total Factor productivity change (TFPch) between 2005–08

Country**	Banks	Age***	2005-06	2006-07	2007-08	MEAN
BiH	BBI	**9**	1.423	1.447	0.873	**1.248**
UK	IBB	**6**	0.917	1.050	0.925	**0.964**
Azerbaijan	Kauther bank	**7********	1.262	1.839	0.803	**1.301**
Turkey	Albaraka Turk	26	1.037	1.037	1.046	**1.040**
Turkey	Kuveyet Turk	22	1.101	0.932	1.010	**1.014**
Qatar	QIIB	20	1.385	1.034	0.812	**1.077**
Bahrain	KHCB	**6**	0.925	1.077	0.799	**0.934**
Bahrain	BisB	32	0.664	1.092	0.846	**0.867**
Bahrain	Shamil bank	29	1.261	1.169	1.173	**1.201**
Bahrain	ABC Islamic	24	0.711	0.288	0.987	**0.662**
Bahrain	SIB	35	0.926	0.877	1.073	**0.959**
Kuwait	Boabyan bank	**7**	0.998	0.854	0.921	**0.924**
Malaysia	RHB	**6**	1.050	0.406	0.944	**0.800**
Malaysia	CIMB	**8**	1.219	0.413	1.107	**0.913**
MEAN			**1.063**	**0.965**	**0.951**	**0.993**

Table 3.2
Banks technological efficiency change (TECch)) between 2005-2008

Country	Banks	2005-06	2006-07	2007-08	MEAN
BiH	BBI	1.412	0.721	0.954	**1.029**
UK	IBB	0.683	0.495	0.928	**0.702**
Azerbaijan	Kauther bank	1.508	1.839	0.803	**1.383**
Turkey	Albaraka Turk	1.420	0.845	0.932	**1.066**
Turkey	Kuveyet Turk	1.303	0.851	0.919	**1.024**
Qatar	QIIB	1.385	1.034	0.812	**1.077**
Bahrain	KHCB	0.925	1.077	0.799	**0.934**
Bahrain	BisB	1.022	0.966	0.800	**0.929**
Bahrain	Shamil bank	1.476	1.066	0.853	**1.132**
Bahrain	ABC Islamic	0.711	0.288	0.987	**0.662**
Bahrain	SIB	0.958	0.913	0.997	**0.956**
Kuwait	Boabyan	1.126	1.017	0.810	**0.984**
Malaysia	RHB	1.050	0.594	0.974	**0.873**
Malaysia	CIMB	1.122	1.341	0.961	**1.141**
MEAN		**1.150**	**0.932**	**0.895**	**0.992**

Table. 3.3
Banks technical efficiency change (TEch) between 2005-2008

Country	Banks	2005-06	2006-07	2007-08	MEAN
BiH	BBI	1.007	1.078	0.915	**1.000**
UK	IBB	1.119	1.343	0.997	**1.153**
Azerbaijan	Kauther bank	1.500	1.000	1.000	**1.167**
Turkey	Albaraka Turk	0.730	1.226	1.122	**1.026**
Turkey	Kuveyet Turk	0.845	1.095	1.100	**1.013**
Qatar	QIIB	1.000	1.000	1.000	**1.000**
Bahrain	KHCB	1.000	1.000	1.000	**1.000**
Bahrain	BisB	0.650	1.131	1.058	**0.946**
Bahrain	Shamil bank	0.855	1.097	1.375	**1.109**
Bahrain	ABC Islamic	1.000	1.000	1.000	**1.000**
Bahrain	SIB	0.967	0.961	1.076	**1.001**
Kuwait	Boabyan bank	0.887	0.840	1.137	**0.955**
Malaysia	RHB	1.000	0.683	0.969	**0.884**
Malaysia	CIMB	1.861	0.308	1.193	**1.121**
MEAN		**1.030**	**0.983**	**1.067**	**1.027**

*TFPch = Total Factor Productivity Change; TEch = Technical Efficiency Change; TECch = Technological Efficiency Change; PTEch = Pure Technical Efficiency Change; and SEch = Scale Efficiency Change.

** Bosnia and Herzegovina (BiH) is a European country located on the Balkan Peninsula. Muslims in BiH constitute 45% or so of the population. Azerbaijan is the largest country in the South Caucasus region of *Eurasia*. According to a 2009 Pew Research Center report, 99.2% of the population is Muslim. Turkey is a Eurasian country. Islam is the dominant religion in Turkey. Nearly 97% of the people are Muslims.

*** Age has been calculated from the date of incorporation until the 1st of 2010.

****The bank has been working in Azerbaijan's banking sector since 1988.The previous name of the bank was "Universal Bank". It began to apply Islamic banking method on October 2002.

Table 3.4
Changes in technical efficiency components between 2005-2008

Country	Banks	05-06		06-07		07-08		MEAN	MEAN
		PTEch	SEch	PTEch	SEch	PTEch	SEch	PTEch	SEch
BiH	BBI	1.032	0.977	1.976	1.016	0.899	1.081	1.302	1.025
UK	IBB	1.347	0.997	1.901	1.002	0.998	0.999	1.415	0.999
Azerbaijan	Kauther	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Turkey	Albaraka.T	0.866	0.844	1.155	1.062	1.000	1.122	1.007	1.009
Turkey	KuveyetT	1.000	0.845	1.000	1.095	1.000	1.100	1.000	1.013
Qatar	QIIB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Bahrain	KHCB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Bahrain	BisB	0.651	0.998	1.141	0.991	1.047	1.011	0.946	1.000
Bahrain	Shamil	0.847	1.008	1.061	1.034	1.347	1.021	1.085	1.021
Bahrain	ABC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Bahrain	SIB	1.000	0.967	1.000	0.961	1.000	1.076	1.000	1.001
Kuwait	Boabyan	0.894	0.992	1.073	0.783	1.024	1.110	0.997	0.962
Malaysia	RHB	1.000	1.000	0.975	0.700	0.885	1.095	0.953	0.932
Malaysia	CIMB	1.804	1.005	0.451	0.683	1.251	1.028	1.169	0.905
MEAN		**1.032**	**0.974**	**1.124**	**0.952**	**1.032**	1.046	1.063	0.991

APPENDIX: Table 4 & 5

Table 4.
Summary statistics of variables employed in the DEA analysis

Factor*	Minimum**	Maximum	Mean	St. Deviation
M1: Total Loans	0.003	15,67.810	513.343	434.834
M1: Total Revenues	0.110	263.530	59.558	59.432
M1: Total Expenses	0.100	16,768.770	33.305	2,236.673
M1: Total Staff Cost	0.016	698.570	21.476	92.534
M1: Total Deposits	0.580	3,172.440	655.458	612.139
M2: Total Loans	13.580	22,668.570	4,227.159	5,058.656
M2: Total Revenues	1.140	1823.300	411.448	494.593
M2: Total Expenses	1.760	1005.160	151.686	194.736
M2: Total Staff Cost	0.450	253.120	60.228	58.353
M2: Total Deposits	25.420	19,682.360	4,216.931	4,595.808
M3: Total Loans	31.430	290.090	100.919	71.045
M3: Total Revenues	3.240	38.460	14.422	9.243
M3: Total Expenses	4.680	39.040	11.297	8.564
M3: Total Staff Cost	0.190	16.580	4.460	4.188
M3: Total Deposits	0.890	289.300	104.166	63.304
M4:Total Loans	29.400	1,278.720	298.965	354.175
M4:Total Revenues	2.211	38.110	10.927	10.700
M4:Total Expenses	1.510	19.600	7.089	5.446
M4:Total Staff Cost	0.850	10.710	3.494	2.722
M4:Total Deposits	47.720	1,214.390	323.312	348.269

Table 5: MPI-Productivity growth : BBI in comparison with small conventional banks in Bosnia and Herzegovina (BiH)

Table 5.1
Banks Total Factor productivity change (TFPch) between 2005–08

Bank	2005-2006	2006-2007	2007-2008	MEAN
BBI	1.268	1.251	1.013	1.177
VAKUFSKA	0.859	1.109	1.141	1.036
ABS	1.136	1.204	1.150	1.163
Investiciono	1.243	1.180	1.968	1.464
Pro Credit	0.867	0.938	0.908	0.904
Balkan Inv.	0.504	1.938	0.888	1.110
Turkish Zira.	1.124	0.576	1.080	0.927
MEAN	**1**	**1.171**	**1.164**	**1.112**

Table 5.2
Banks technological efficiency change (TECch)) between 2005-2008

Bank	2005-2006	2006-2007	2007-2008	MEAN
	1.052	1.223	1.074	1.116
BBI	0.949	1.033	1.018	1
VAKUFSKA	0.947	1.204	1.150	1.100
ABS	0.942	1.012	1.968	1.307
Investiciono	0.867	1.102	1.097	1.022
Pro Credit	0.504	1.993	0.888	1.128
Balkan Inv.	1.124	0.576	1.080	0.927
Turkish Zira.	**0.912**	**1.163**	**1.182**	**1.086**
MEAN				

Table 5.3
Banks technical efficiency change (TEch) between 2005-2008

Bank	2005-2006	2006-2007	2007-2008	MEAN
BBI	1.206	1.023	0.943	1.057
VAKUFSKA	0.905	1.074	1.121	1.033
ABS	1.200	1.000	1.000	1.067
Investiciono	1.320	1.166	1.000	1.162
Pro Credit	1.000	0.851	0.828	0.893
Balkan Inv.	1.000	1.000	1.000	1
Turkish Zira	1.000	1.000	1.000	1
MEAN	**1.090**	**1.016**	**0.985**	**1.030**

Table 5.4
Changes in technical efficiency components between 2005-2008

Bank	2005- 2006		2006- 2007		2007- 2008		MEAN	MEAN
	PTEch	SEch	PTEch	SEch	PTEch	SEch	PTEch	SEch
BBI	1.000	1.206	1.000	1.023	1.000	0.943	1.000	1.057
VAKUFSKA	0.937	0.965	1.042	1.030	1.116	1.005	1.032	1.000
ABS	1.031	1.164	1.000	1.000	1.000	1.000	1.010	1.055
Investiciono	1.000	1.320	1.000	1.166	1.000	1.000	1.000	1.162
Pro Credit	1.000	1.000	1.000	0.851	1.000	0.828	1.000	0.893
Balkan Inv.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Turkish Zira	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MEAN	**0.995**	**1.093**	**1.006**	**1.010**	**1.017**	**0.968**	**1.006**	**1.024**

*All numbers in are in Million £ after deflation.

** Kauther bank in Azerbaijan, BBI and IBB in Bosnia - Herzegovina "BiH" and the UK respectively, are found to have the lowest value of outputs and inputs. This is simply due to the fact that these banks are newly established in Europe.

APPENDIX: Table 6 & 7

Table 6.
MPI-Productivity growth : IBB in comparison with small conventional banks in the UK.

Table 6.1.
Banks Total Factor productivity change (TFPch) between 2005–08

Bank	2005-2006	2006-2007	2007-2008	MEAN
IBB	0.784	0.906	0.934	0.875
Turkish Bank	0.966	1.012	1.050	1.009
ICBC London LT	1.029	1.291	0.854	1.058
Habib Allied	1.004	1.030	0.993	1.009
Ghana INT	1.009	1.013	0.971	0.998
Bank of Beirut (UK)	1.021	1.141	1.323	1.162
Bank leumi UK	1.028	1.008	1.006	1.014
MEAN	**0.977**	**1.057**	**1.019**	1.018

Table 6.2.
Banks technological efficiency change (TECch)) between 2005-2008

Bank	2005-2006	2006-2007	2007-2008	MEAN
IBB	0.784	0.906	1.008	0.899
Turkish Bank	0.904	0.971	1.045	0.973
ICBC London LT	1.029	1.291	0.854	1.058
Habib Allied	0.917	0.985	0.993	0.965
Ghana INT	1.009	1.013	1.095	1.039
Bank of Beirut (UK)	1.021	1.141	1.323	1.162
Bank leumi UK	1.031	1.004	1.006	1.014
MEAN	**0.956**	**1.044**	**1.046**	1.016

Table 6.3.
Banks technical efficiency change (TEch) between 2005-2008

Bank	2005-2006	2006-2007	2007-2008	MEAN
IBB	1.000	1.000	0.927	0.976
Turkish Bank	1.068	1.043	1.005	1.039
ICBC London LT	1.000	1.000	1.000	1.000
Habib Allied	1.095	1.045	1.000	1.047
Ghana INT	1.000	1.000	0.887	0.962
Bank of Beirut (UK)	1.000	1.000	1.000	1.000
Bank leumi UK	0.997	1.003	1.000	1.000
MEAN	**1.022**	**1.013**	**0.974**	1.003

Table 6.4
Changes in technical efficiency components between 2005-2008

Bank	2005-2006		2006-2007		2007-2008		MEAN	MEAN
	PTEch	SEch	PTEch	SEch	PTEch	SEch	PTEch	SEch
IBB	1.000	1.000	1.000	1.000	0.931	0.995	0.977	0.998
Turkish B.	1.092	0.978	1.000	1.043	1.000	1.005	1.031	1.009
ICBC London	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Habib Allied	1.028	1.065	1.041	1.004	1.000	1.000	1.023	1.023
Ghana INT	1.000	1.000	1.000	1.000	1.000	0.887	1.000	0.962
Bank of Beirut	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Bank leumi	1.000	0.997	1.000	1.003	1.000	1.000	1.000	1.000
MEAN	**1.017**	**1.006**	**1.006**	**1.007**	**0.990**	**0.984**	**1.009**	**0.999**

Table 7
Summary statistics of the exogenous variables in the DEA- second stage/ the (OLS)-regression*

Exogenous variables	Measurement and *expected* effect on efficiency
β_1 *PBjt*(ROA)(E1,E2)	Profitability=net income to total assets. (+)**
β_2 *PERjt* (E1,E2)	Personal expenses as a proxy of skills utilization measured by total amount of wages and salaries to total assets. (-): efficient banks are expected to have lower cost because of IT.
β_3 *LIQjt* (E1,E2)	Liquid assets to total deposits and short term funding as a proxy of liquid asset ratio. (+ or -)
β_4 *lOG(AS)jt* (E1,E2)	(Log.)Total assets as a proxy of bank's size. (+)
β_5 *LTAjt* (E1,E2)	The proxy of lending intensity= total loans to total asset. (+): loans are the main source of revenue.
β_6 *DEPOjt* (E1,E2)	Total deposits the proxy of market share. (+): they are considered the main source of progress.
β_7 *INDjt* (E1,E2)	The effect of independency. Dummy variable; (1) if a bank is managed by a parents(subsidiary), (0) if it is stand alone bank. (+ or -)
β_8 *AGEjt* (E1,E2)	The effect of age and experience. Dummy variable; (1) if <10 years, (0) otherwise. (+)
β_9 *LEVjt* (E1,E2)	Leverage= total assets to equity. (-)
β_{10} *GDPjt* (E1)	The percentage change in gross domestic production per capita (favorable economic condition will affect positively on demand and supply of banking services).(+ or -)
β_{11} *GEOjt* (E1)	Geographical location effect. Dummy variable; (1) if the bank is located in Europe; = (0) otherwise. (+): Islamic banks in Muslim countries are more Efficient.
β_{11}DIVER*jt* (E2)	Diversification effect. Dummy variable; (1) if high diversified, (0) otherwise (+): unless it leads to higher risk.

* i) One of the important assumptions underlying the OLS regression method is that the explanatory variables are (linearly independent). As a rule of thumb if $r \geq 0.70$ between variables they should not both appear in the equation. To test for Autocorrelation (except for dummies), we use: Tolerance, VIF and Durbin-Watson statistics. As a result of the test using (SPSS-17) it is clear that the Tolerance is >0.20, VIF <5, and the D-W is around (very close) to 2, which indicates the absence of Autocorrelation, and thus ,the Multi-co linearity does not appear to be a serious problem.
ii) We apply the Scatter plots and Skewness statistics. As a rule of thumb, |s| > 1 indicates potentially serious non-normality) to test for both linearity and normality. We find that these assumptions have almost certainly been met. However, when nonlinear relationships are thought to be present, investigators typically seek to model them in a manner that permits them to be transformed into linear relationships.
iii) Despite the fact that the multiple regression procedures are not greatly affected by minor deviations from the assumptions of linearity and normality (normal distribution contains only linear relationships between variables) of data, we use non-linear transformation (Logarithm Transformation for all variables, except dummies) to meet the previous main assumptions and to produce more accurate results.
iv) In order to get rid the negative values for a variable, we added a constant to move the minimum value of the distribution above 0, preferably to 1.00. Hence, we use log+4 in our analysis to transfer the logarithms results to positive numbers.
vi) For the original data values that include negative numbers, it is not possible to apply many nonlinear transformations (the log of a negative number is undefined). In this situation we added a constant to all data values that make them positive. As a rule of thumb, we add the smallest constant that will convert the largest negative data value to a value greater than 1.
v) Our OLS-regression analysis shows a strong correlation between the observed values of the response variables and the values predicted by the model (all models) (R^2 > 60%). Eventually, using the ANOVA Tables, we clearly reject the null hypothesis and conclude that at least one of the predictors is related to the efficiency scores. This means that the models have been estimated are not only theoretically construct but exists and statistically significant (i.e. M1, $F_{13, 42}$=3.419, P<.001, M2, $F_{11, 32}$ = 1.572, P<.001, in M3, $F_{10, 17}$=1.505, P<0.10, and in M4, F11, 16=4.128, P<.001).
** (+) indicates a positive effect, (-) indicates a negative effect, (0) indicates (No) effect

Chart 1-4. Mean DEA-efficiency scores by individual bank: model-M1, M2, M3, and M4.

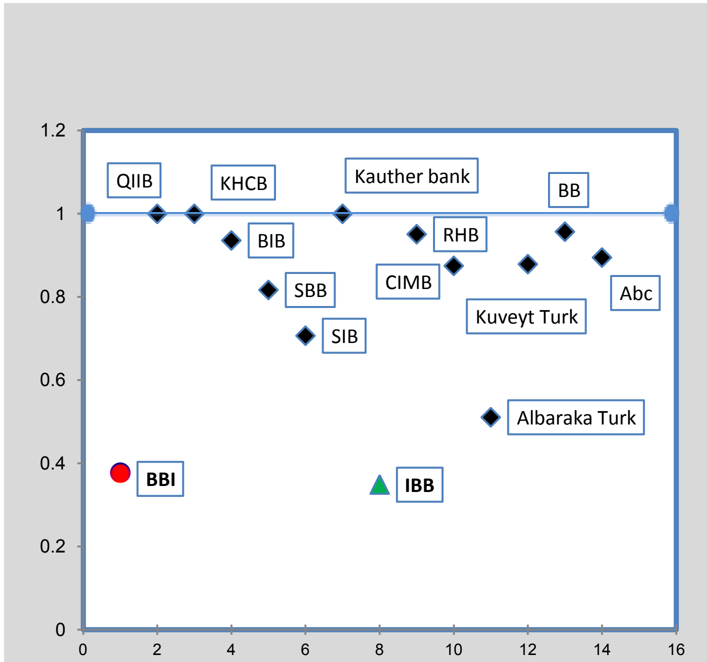

Chart 1. Mean efficiency scores by bank- M1

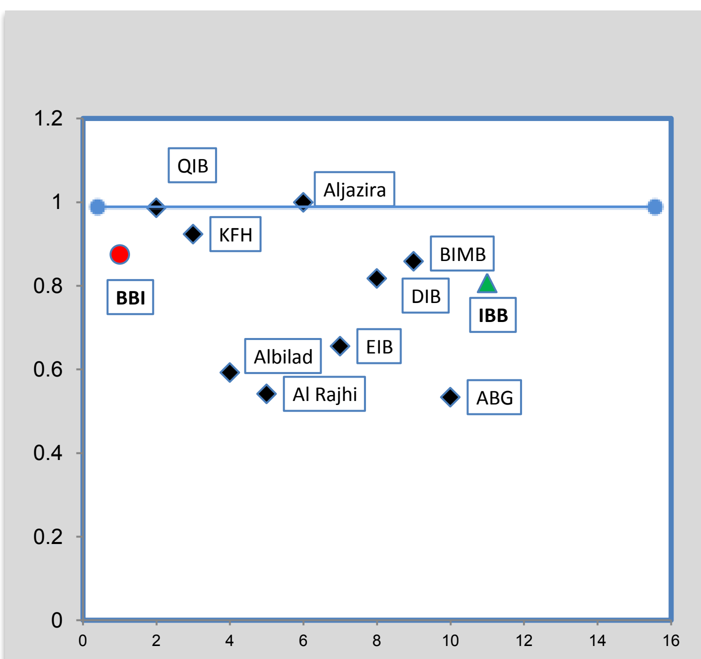

Chart 2. Mean efficiency scores by bank- M2

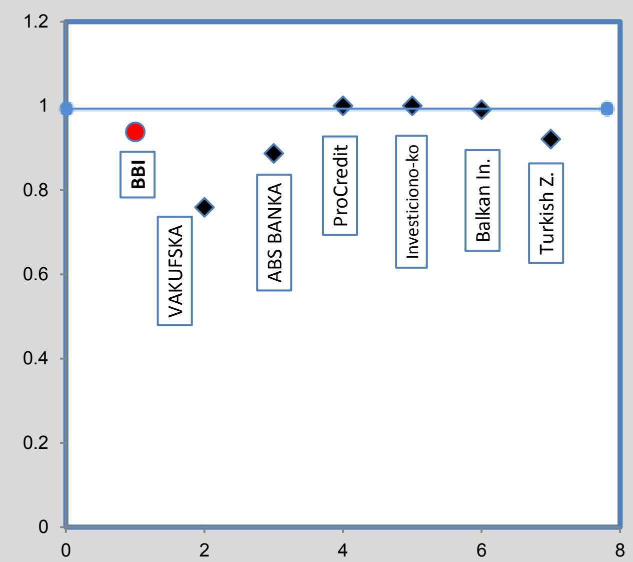

Chart 3. Mean efficiency scores by bank- M3

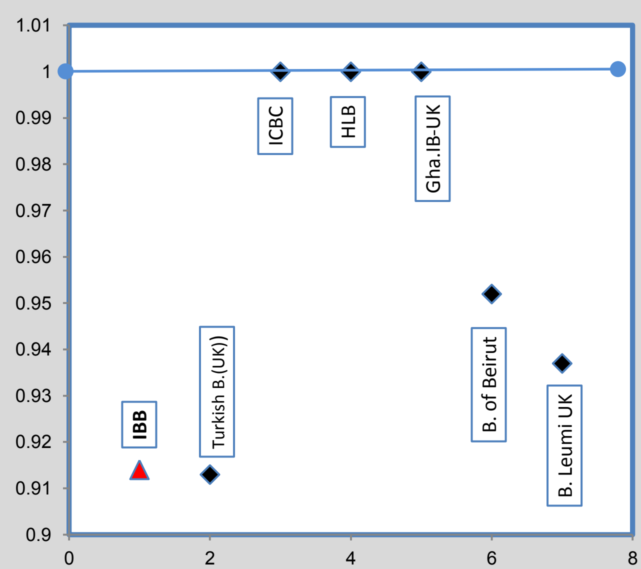

Chart 4. Mean efficiency scores by bank- M4