Examining Performance of Islamic Banks in Bangladesh Using Stochastic Frontier Analysis and Maqasid Model

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ABSTRACT

The current study uses the parametric Stochastic Frontier Approach (SFA) with the Maqasid Model, Performance Measures based on Maqasid al Shariah (PMMS) to empirically evaluate the performance of Bangladeshi Islamic commercial banks from 2005 to 2018. In accordance with the SFA model, Islamic commercial banks had an average cost efficiency value of 0.78 between 2005 and 2018, which was greater than traditional state banks' (0.781), but lower than local private banks' (0.879) and international banks' (0.969). This implies that Islamic and other commercial banks can save identical stage of output with the same quantity of resources. Under the PMMS Model empirical evidences show that Islamic banks experienced a low level of performance based on the Maqasid Index which ranges from 19.16% to 23.07%. The current article provides significant information on performance gaps of Islamic commercial banks and its determinants. The regulators, policy makers and managers can adopt necessary policy actions to improve performance of Islamic commercial banks from perspective of cost efficiency and welfare issue.

Keywords: Bangladesh, Cost efficiency, Islamic Bank, Maqasid al Shariah, Stochastic Frontier Approach

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INTRODUCTION

Bangladesh, a South Asian nation with a majority of Muslims and lower middle-class income, has seen amazing growth in Islamic banking with the fast globalization of Islamic finance, mostly due to the system's widespread public backing. At present out of 62 commercial banks, 10 commercial operate as full-fledged Islamic banks in Bangladesh (Bangladesh Bank, 2020). Additionally, 535 windows and 23 branches totaling 11 traditional commercial banks offer financial services compliant with Shariah.

The Bangladesh Islamic banking sector accounts for 28 percent market share in terms of deposits and financing in 2022 (Bangladesh Bank, 2020). Following the weak capital market, the Bangladeshi banking sector has to play key roles for promotion of savings-investment process towards higher economic growth and job creation. Given this, Bangladesh needs a well-performing efficient banking sector that can mobilize resources and allocate these resources among productive sectors and maintain stability and resiliency combating risks and shocks.

In order to achieve financial viability and handle welfare issues in keeping with the goals of Islamic Shariah, sometimes referred to as Maqasid al Shariah, Islamic banks must evaluate their performance using both an economic efficiency-based methodology and a Maqasid welfare-based approach. The economic efficiency provides information on commercial viability while the Maqasid index shows whether Islamic banks offer financial services according to the goals of Shariah.

The key objectives of the current study include (i) measuring and comparing performance of Islamic banks based on cost efficiency and welfare indicators, (ii) examining the key factors affecting the performance of Islamic banks and traditional commercial banks and (iii) providing policy options for promotion of Bangladesh's Islamic banking industry.

The paper provides valuable insights on level and determinants of performance of Shariah banks for regulators, policy makers and managers. Regulators can instruct Islamic banks to improve performance and managers can undertake steps accordingly. Investors and general customers can also benefit from the empirical findings of the study that provides vital

information. In addition, the simultaneous use of two methods in the study for assessing performance of Islamic banks from viewpoints of economic efficiency and welfare issue would add new value to performance analysis literatures of Islamic banks in other countries which operates Islamic banking. Moreover, researchers would also find necessary inputs from the findings of the study for conducting studies on Islamic banking, a potential growing sub-sector in global financial architecture.

LITERATURE REVIEW

Definition of Performance of Islamic Banks

One way to look at banking performance is from the standpoint of productivity, efficiency, competition, profitability and concentration (Bikker & Bos, 2008). According to leading Finance authors Rose & Hudgins (2013) bank performance should be measured against its specific objectives and accordingly, traditional commercial bank sets decreasing of cost or increasing of profit for shareholders as well as depositors as its prime objective.

As opposed to this, Islamic banking firms conduct their business with the dual goals of assuring fair profit for their financial sustainability and promoting social well-being in accordance with Islamic Shariah or Maqasid Al Shariah (Hasan, 2004; Mohammed et al., 2008; Antonio et al., 2012; Asutay & Harningtyas, 2015; Mohammed et al., 2015; Ascarya & Sukmana, 2016).When an Islamic bank achieves efficiency from the viewpoints of both economic (cost) efficiency for financial sustainability and community welfare issues in keeping with the objectives of Islamic Shariah, also known as Maqasid al Shariah, it is said to have achieved efficiency. The current study measures performance of Islamic banks by employing both economic or cost efficiency and welfare indicators in line with the Maqasid Al Shariah.

Empirical Studies on Cost Efficiency as Islamic Bank Performance Measure

Researchers employ a variety of efficiency measures including cost, revenue, profit, and technical efficiency (Sharmaet al., 2013; Bhatia et al., 2018). More academics are using cost efficiency to assess the efficiency of

traditional banks functioning in various nations, including developed and developing nations (Berger & Humphrey, 1997; Fethi & Pasiouras, 2010; Sharmaet al., 2013; Bhatia et al., 2018). Following the rapid expansion of Islamic banking worldwide, academics have begun to study the efficiency of Islamic banks operating in Muslim-majority nations (Abedifar et al., 2016).

Due to some distinct, specific factors, the current study employs cost efficiency to gauge how well Islamic banks in Bangladesh perform in terms of efficiency. Firstly, as banking firm is multi-inputs-outputs nature firm, cost function is easy to handle than production function. Secondly, cost efficiency may reduce expenditures for banking operations and costs of financial intermediation for turning savings into investments at lower cost. This lower cost savings-investment process contributes greatly to promote economic development (Fries & Taci, 2005). Thirdly, Islamic banks are thought to perform better when cost efficiency is used as a performance indicator because these Shariah-compliant institutions never charge interest on any transactions, incur higher capital expenses, and prioritize achieving community welfare over maximizing profits (Abdul-Majid et al., 2011). Fourthly, cost efficiency may be regarded as a suitable measure of Islamic banking performance as cost efficiency is directly related to ethical banking which is a core feature of Islamic banking. Islamic banks are required to avoid unnecessary expenditures for ensuring productivity and complying with Shariah rules.

The bank's cost efficiency (CE) measures how well a bank conducts its business activities compared to the performance attained by the most efficient bank which generates the similar level of output subject to the same environmental conditions (Dong et al., 2014). CE is determined by comparing the minimum costs (TC_m) for producing a given amount of output to the actual costs (TC_a) for producing the same amount of output in the same technological and regulatory context.

Major studies measuring Islamic banking performance based on cost efficiency include Srairi (2010), Abdul Majid et al. (2011) and Kablan and Yousfi (2011). A few investigations, meanwhile, have looked at the performance of Bangladesh's traditional and Islamic banks in terms of cost effectiveness.

In 2014, Baten and Begum looked on the cost and profit effectiveness of Bangladeshi Islamic banks between 2001 and 2010. The authors used the SFA technique and discovered that, on average, Islamic banks had cost efficiency of 56% and profit efficiency of 82% over the study period. The other earning assets impacted cost efficiency positively, but cost of fund affected it negatively. The cost of funds influenced profit efficiency negatively.

During the period of 2001 to 2011, Miah and Sharmeen (2015) sought to explore the link among capital, risk, and efficiency of Shariah and traditional commercial banks in Bangladesh. Efficiency was calculated by the authors using Stochastic Frontier Analysis (SFA). According to the empirical findings, traditional banks were more cost-effective than Islamic banks. In order to evaluate the performance of 19 traditional commercial banks and 5 Islamic banks in Bangladesh between 2004 and 2008, Ara S. (2016) used the SFA approach. The author reported that traditional commercial banks obtained higher cost efficiency score (0.92) compared to Islamic banks (0.88).

Using the stochastic frontier analysis (SFA) methodology, Hassan and Hassan (2018) studied the cost efficiency of Bangladeshi commercial banks from 2011 to 2015. Thirty-five commercial banks made up the sample, including 22 private and 6 public banks (including 7 Islamic). According to the findings, private commercial banks had the greatest efficiency rating (0.9142), followed by Islamic banks (0.8450) and public banks (0.8248).

Empirical Studies Using Maqasid Index to Measure Islamic Bank Performance

The Maqasid al Shariah means goals of the Shariah. The protection of five fundamental elements—religion (al-din), life (al-nafs), intellect (al-'aql), progeny (al-nasl), and money (al-ml)—is what Imam al-Ghazali stated as the goals of Shariah (Chapra et al., 2008).Since Islamic banking is Shariah based banking, its entire areas of operations need to be guided by the objectives of Shariah (Hasan, 2004; Mohammed et al., 2008; Dusuki & Bouheraoua, 2011).Islamic banks can achieve the goals of Shariah, which include maintaining the welfare of the community and preventing harm, by using Maqasid al Shariah principles. According to Laldin and Furqani

(2013), there are three goals in Islamic finance, including distributing wealth fairly, following honest and open procedures, and upholding justice. The authors suggest three ways to achieve the goals, including facilitating financial contracts, setting standards and principles, and encouraging social responsibility. Using an index based on the Maqsid, a small number of Islamic scholars have evaluated the performance of Islamic banks (Mohammed et al., 2008 & 2015; Ascarya & Sukmana, 2016).

To assess how well Islamic banks are performing in accordance with the goals of Shariah Mohammed et al. (2008) established the model known as "Performance Measures based on Maqasid al Shariah (PMMS)". The authors looked at six Islamic banks with operations in six Muslim-majority nations and found that five of them performed poorly according to Maqasid al Shariah, with scores ranging from 0.0308 to 0.1081. Using the same PMMS model, Antonio et al., (2012) also found meagre performance of two Indonesian banks (0.1783 & 0.1619) and two Jordanian banks (0.0815 & 0.1029).

According to Alhammadi et al. (2022), the average Maqasid index score for three Indonesian Islamic banks between 2010 and 2018 was just 17.84%, 21.24%, and 30.13%. The study recommended that, in addition to the traditional performance measurements, regulatory authorities and all persons related with Islamic banks need to apply a benchmark that focuses on social justice and ethical character of Islamic economics and finance as embodied in the objectives of Shariah.

In brief, the current study finds key research gaps after reviewing the existing literatures. Firstly, the majority of current studies base their analysis of Islamic bank performance on economic or cost efficiency. Secondly, only a small number of research computed Islamic bank performance using the Maqasid based models. The current study analyses Islamic bank performance from the viewpoints of both cost efficiency and welfare issues in order to close the research gaps.

METHODOLOGY

The current study uses two models, Stochastic Frontier Analysis (SFA) and Performance Measures based on Maqasid Al Shariah (PMMS) to calculate the performance of Islamic institutions. While SFA is used to measure performance of Islamic banks in terms of cost efficiency, PMMS is used to calculate the performance from the standpoint of Maqasid al Shariah.

Stochastic Frontier Analysis (SFA): Model Specification

The current study uses a single-stage stochastic frontier analysis (SFA) model created by Batesse and Coelli (1995) to estimate the cost efficiency of a sample of Shariah and traditional commercial banks in Bangladesh for the years 2005–2018.

The translog cost function is used in the study to compute cost efficiency. The translog cost function includes total costs (TC) as the dependent variable and it uses 3 output variables and 3 input price variables as independent variables. Total investments, other earning assets, and off-balance-sheet items are three output variables that are represented by q1, q2, and q3, respectively. Deposit price, employee price and fixed asset price are the three input price variables, and they are symbolized by the letters p1, p2, and p3, accordingly.

For assessing the impacts of control and environmental variables on cost function, the study also includes control variables like equity capital (z1), time trend (T), non-performing loan (NPL) (proxy for risk), market share (MS) and concentration ratio (HHI) in the cost function. Additionally, the cost inefficiency function incorporates bank size (SIZE), liquidity (LIQ), financial intermediation ratio (FIR), and two macroeconomic factors, namely GDP growth (GDP) and inflation rate (INF) to examine the influence of those variables on cost inefficiency. To explore the effects of the two dummy variables on cost inefficiency, the cost inefficiency function also includes the global financial crisis of 2008 (GFC) and the Bangladesh stock market crash of 2011 (SMC). In Appendix II, variables defined using the intermediation approach pioneered by Sealey and Lindley (1977) are mentioned.

According to Battese and Coelli 1995, Dong et al. (2014), and Hassan and Hassan (2018), the empirical model for translog stochastic cost frontier assumes the following form based on the aforementioned dependent variable, independent variables, control, and environmental variables.

$$ln(TC_{it}/P_3) = \beta_0 + \beta_1 lnq_1 + \beta_2 lnq_2 + \beta_3 lnq_3 + \beta_4 lnP_1/P_3 + \beta_5 lnP_2/p_3 + \beta_6 lnz_1 + \beta_7 T + 0.5[\beta_{11} lnq_1^2 + \beta_{22} lnq_2^2 + \beta_{33} lnq_3^2 + \beta_{44} (ln\ p1/P3)^2 + \beta_{55} (ln\ p2/P3)^2 + \beta_{66}(lnz_1)^2 + \beta_{77} (T^2)] + \beta_{12} lnq_1 * lnq_2 + \beta_{13} lnq_1 * lnq_3 + \beta_{14} lnq_1 * ln(P1/P3) + \beta_{15} lnq_1 * ln(P2/P3) + \beta_{16} lnq_1 * lnz_1 + \beta_{17} lnq_1 * T + \beta_{23} lnq_2 * lnq_3 + \beta_{24} lnq_2 * ln(P1/p3) + \beta_{25} lnq_2 * ln(P2/p3) + \beta_{26} lnq_2 * lnz_1 + \beta_{27} lnq_2 T + \beta_{34} lnq_3 * ln(P1/p3) + \beta_{35} lnq_3 * ln(P2/p3) + \beta_{36} lnq_3 * lnz_1 + \beta_{37} lnq_3 * T + \beta_{45} ln(p1/p3) * ln(P2/p3) + \beta_{46} ln(p1/p3) * lnz_1 + \beta_{47} ln(p1/p3) * T + \beta\_56\ ln(p2/p3) * lnz_1 + \beta\_57\ ln(p2/p3) * T + \beta_{67} lnz_1 T + \tau_1 NPL_{it} + \tau_2 MS_{it} + \tau_3 HHI\ t + v_{it} + u_{it}$$

The two random errors v_{it}, a systematic error, and u_{it}, a non-negative random variable are assumed to be independently distributed and uncorrelated with the explanatory variables. Inaccurate measurements, measurement errors, and approximation mistakes all contribute to statistical noise, which is taken into account by the error term vit with zero mean and variance, $v_{it} \sim N(0, \sigma^2 v)$. The analysis applies basic symmetry limits to equation 1 as well as homogeneity restrictions by normalizing input prices and total costs by the cost of fixed assets (p3).

As the stochastic frontier analysis (SFA) assumes a non-negative nature of inefficiency term, u_{it}, higher inefficiency leads to excessive costs. The parameterization of the inefficiency term, uit allows time-varying inefficiency as suggested by Battese and Coelli (1995). The following can be used to specify the inefficiency cost function:

$$u_{it} = \delta_0 + \delta_1 SIZE_{it} + \delta_2 FIR_{it} + \delta_3 LIQ_{it} + \delta_4 GDP_{it} + \delta_5 INF_{it} + \delta_6 GFC_t + \delta_7 SMC_t + e_{it} \quad (2)$$

Here SIZE stands for bank size, FIR for financial intermediation ratio, LIQ for liquidity, GDP for Gross Domestic Product rate, INF for annual inflation rate, GFC for Global financial Crisis in 2008 and SMC Share market crash of Bangladesh in 2011. The random error term that denotes

cost inefficiency is normally distributed with truncation below zero. The point of truncation is , i.e., where represents variables that influence banks' inefficiency directly and costs indirectly.

The current study uses the maximum likelihood estimation (MLE) to estimate the parameters of equations 1 and 2 simultaneously to measure the cost efficiency of Islamic and traditional banks following Dong et al. (2014), Ara (2016) and Hassan and Hassan, (2018). The maximum likelihood estimation (MLE) is selected among different methods of estimation since maximum likelihood (ML) estimator is consistent and asymptotically normally distributed (Coelli et al., 2005). The likelihood function can be presented from the perspective of variance parameters, and where estimated γ (gamma) denotes the part of inefficiency in the composite random errors which ranges between 0 (zero) and 1 (one) (Robin, 2015). Following (Coelli,1996), the study use the computer program FRONTIER Version 4.1 to estimate the parameters of equation 1 and equation 2.

Likelihood Ratio Tests for Model Specification

Following Coelli et. al. (2005), Baten and Begum (2014) and Robin (2015), our study runs three null hypotheses for model specification test using Likelihood Ratio (LR). To determine whether our model is suitable for the sample data, we test the first null hypothesis (equation 3). To determine whether technical inefficiency effects exist, we test the second null hypothesis. The third one is conducted to see if the impacts of inefficiency are a linear function of the environmental and control factors chosen for the inefficiency function.

The likelihood ratio can be expressed as follows:

$$\lambda = -2\{\ln L(H0)/ \ln L(H1)\} = -2\{\ln L(H0)-\ln L(H1)\} \quad (3)$$

L (H0) in this case displays the likelihood ratio function's greatest value for the null hypothesis. On the other hand, L (H1) stands for the likelihood ratio function's maximum value under the alternative hypothesis.

If the sample size is large enough, a mixed chi-square distribution for the likelihood ratio can be observed. When LR ratio () is higher compared to critical value (), we reject the null hypothesis.

Performance Measures based on Maqasid al Shariah (PMMS): Model Specification

The 'Performance Measures based on Maqasid al Shariah (PMMS) model' promoted by Mohammad M. U. et al. (2008) is applied in the current study to measure performance of Islamic banks from the perspective of Shariah. The following five steps are necessary for building the PMMS model:

Identifying the Objectives of Shariah

The first step in building the PMMS model is to choose three Shariah objectives, such as promoting public welfare (Jalb al Maslahah), establishing justice (Iqama al Adle), and educating the individual (Tahdhib al Fard). Mohammad et al. (2008) considers these objectives in the PMMS model inspired by leading Islamic scholars, (Abu Zaharah & Muhammad 1997) and Ibn' Ashur (1998).

The first objective, "educating the individual," refers to improving the understanding and skills of bank employees as well as spreading awareness of Islamic banking among all stakeholders, including general consumers. The second objective, establishing justice means supporting the poor, promoting investment in partnership modes and elimination of injustice generated from riba (interest). The third objective, promoting public welfare denotes earning fair profit, redistribution of wealth through payment of zakat and enhancing investment in real sectors for job creation.

Converting Concepts into Dimensions, Elements and Performance Ratios

The conversion of three Shariah objectives into measurable elements is the send step of construction of the PMMS model. In the second step, we used "empowering the poor" as dimension D4 and "supporting microfinance" as element E5 because Islamic banks in Bangladesh do not maintain a "Profit Equalization Reserve." As there are operations of Islamic microfinance in Bangladesh, it is rationale to consider it as a measurable element. Information on 10 performance ratios and 10 elements are shown in Appendix V, Table 1.

Assigning Weights for Objectives and Elements

The final stage of creating the PMMS model is determining the weights for each Shariah objective and each component, as specified by Muhammad et al. (2008). Data on weight of each Shariah objective and each element is mentioned in Table 2 of Appendix V.

Determination of Performance Index for Each Objective

The use of a quantitative technique called the Simple Additive Weighting (SAW), created by Hwang et al. (1981), for the weighting, aggregating, and ranking procedure, is the fourth step in the building of the PMMS model. Each performance ratio is multiplied by the respective weights of each element and its accompanying objective in order to create a performance indicator for each Shariah objective. In order to obtain a weighted ratio, performance index, or indication for each aim, the products are multiplied and then added.

Performance Indicator for First Objective (Education)- Mathematical process of obtaining "Performance Indicator-PI" for first Shariah objective is elaborated below:

$$PI_1 = w_1^1 \, x \, E_1^1 \, x \, R_1^1 + w_1^1 \, x \, E_1^2 \, x \, R_1^2 + w_1^1 \, x \, E_1^3 \, x \, R_1^3 + w_1^1 \, x \, E_1^4 \, x \, R_1^4$$
$$= w_1^1 \, (E_1^1 \, x \, R_1^1 + E_1^2 \, x \, R_1^2 + E_1^3 \, x \, R_1^3 + E_1^4 \, x \, R_1^4 \qquad (4)$$

In this case, PI1 stands for the first objective (education), w^1_1 for the weight of the first Shariah objective, E_1^1 to E_1^4 for the weight of the first objective's constituent elements, and R_1^1 to R_1^4 for the performance ratio based on the first objective's constituent aspects.

Performance Indicator for Second Objective-The mathematical process of obtaining "Performance Indicator-PI" for second Shariah objective is elaborated below:

$$PI_2 = w_2^2 \, x \, E_2^1 \, x \, R_2^1 + w_2^2 \, x \, E_2^2 \, x \, R_2^2 + w_2^2 \, x \, E_2^3 \, x \, R_2^3$$
$$= w_2^2 \, (E_2^1 \, x \, R_2^1 + E_2^2 \, x \, R_2^2 + E_2^3 \, x \, R_2^3) \qquad (5)$$

Here, PI_2 stands for the second objective (justice), w^2_2 stands for the weight of the second objective, E_2^1 to E_2^3stands for the weight of the elements, and R_2^1 to R_2^3 displays performance ratio depending on the elements of the second objective.

Performance Indicator for Third Objective (Welfare)-The mathematical process of obtaining "Performance Indicator-PI" for of third Shariah objective is elaborated below:

$$PI3 = w_3^3 \, x \, E_3^1 \, x \, R_3^1 + w_3^3 \, x \, E_3^2 \, x \, R_3^2 + w_3^3 \, x \, E_3^3 \, x \, R_3^3$$
$$= w_3^3 \, (E_3^1 \, x \, R_3^1 + E_3^2 \, x \, R_3^2 + E_3^3 \, x \, R_3^3) \quad (6)$$

w^3_3 stands for the third objective's weight, E_3^1 to E_3^3 for the elements' weight, and R_3^1 to R_3^3 for the performance ratio based on the third objective's constituent elements. PI^3 stands for the third objective.

The Maqasid Index and PMMS Model

The last and final step for the construction of the PMMS model lies in deriving the Maqasid Index (MI) by applying 3 Performance Indicators based on 3 Shariah objectives such as education, justice and public welfare (equation 7).

$$MI = PI_1 + PI_2 + PI_3 \quad (7)$$

By employing three performance indicators for three Shariah objectives and the Maqasid Index, the study creates the " 'Performance Measures based on Maqasid al Shariah (PMMS) model. The PMMS model is used to assess Islamic bank performance from a Maqasid al Shariah perspective.

Data

Under the SFA model, the sample size consists of 5 Islamic commercial banks among 10 full-fledged commercial Islamic banks covering 81% assets of Islamic banks operating in Bangladesh as these banks cover our study period 2005-2018 period. The five Islamic banks are Islami bank Bangladesh Ltd. (IBBL), Al Arafah Islamic Bank Ltd. (AIBL), Social Islami Bank Ltd (SIBL), EXIM Bank Ltd (EXIM) and Shahjalal Islami Bank Ltd (SJIBL).

In order to compare Islamic commercial banks' performance to that of traditional commercial banks, we include 19 traditional commercial banks in the sample. Among 19 traditional commercial banks in the sample, 4 traditional commercial banks are under state ownership (Sonali, Agrani, Janata and Rupali),10 traditional commercial banks under domestic private ownership (Pubali, AB, City, IFIC, UCBL, DBBL, Prime, Southeast and Brac) and 5 traditional commercial banks under foreign ownership (Standard Chartered, HSBC, Citi, State Bank of India and Habib bank). Under the PMMS model, the same 5 Islamic banks are selected.

The current study makes use of secondary data collected from a variety of sources, including the annual reports and financial statements of representative Bangladeshi traditional and Islamic commercial banks. We collect banking related data from financial statements including annual report of each Islamic and traditional commercial bank which are available on website. We compile and validate macroeconomic data from three reports: the World Bank (WB), the International Monetary Fund (IMF), and the Finance Division of the Ministry of Finance of Bangladesh. The first report is titled "Economic Survey," and the other two are "International Financial Statistics" (IFS) and "World Development Indicators," respectively.

RESULTS AND DISCUSSIONS

With three outputs, three input prices, square interactions between the input price and output variables, and three output prices, the Translog cost frontier model was employed in the study to assess cost effectiveness. We also included environmental and control factors in the model.

Results and Discussions based on Stochastic Frontier Analysis

Maximum Likelihood Estimates of Translog Stochastic Cost Frontier Model

In Appendix III, the results of the cost model's maximum likelihood (ML) estimation are displayed. Any variable with a substantial positive (negative) coefficient is likely to have an impact on the overall cost of the bank.

The bank's investment (loan/advances in the case of a traditional bank) is shown to be highly significant among the output variables with positive coefficients of 0.67, indicating that it considerably affects overall cost in the positive direction. As investments accounts for a lion's share of outputs, increase of bank investments (loan/advances in case of traditional bank) plays key roles in raising bank's total costs. The positive and significant impact of investment on bank's total costs is also supported by other studies (Dong, 2010; Robin, 2015). The coefficient of the second output variable, other earning assets is negative (0.14) and significant while the third output variable, off-balance sheet items is found statistically insignificant.

Among input price variables, coefficients of price of deposits, cost of staff and physical capital are found positive at 1% significance level indicating that these factors increase bank's total cost. As amount of cost of deposits and its positive price coefficient are higher than those of staff costs and fixed assets and their positive coefficients (0.22) and 0.14), banks total costs are heavily influenced by price of deposits compared to cost of staff and fixed assets. The other empirical studies also found a positive and significant impact of cost of deposits, staff and physical assets on bank's total costs (Dong, 2010; Boucinha et al., 2013 and Robin, 2015).

Without taking into account the controls, equity capital (z1) is found to be significantly negative with a coefficient of 0.18 at the 5% level of significance, suggesting that banks with higher capital levels are more cost-effective. Other research also supports the considerable and detrimental effect of equity capital on banks' overall costs (Dong, 2010; Rosman et al., 2014 and Robin, 2015).

The non-performing investment/loan (NPL) is found to be statistically significant with a positive coefficient of 0.14 at the 1% significant level indicating that higher NPL increases bank's total costs. Higher NPL increases bank's total costs by boosting up monitoring and legal costs which leads to a fall in bank cost efficiency (Reda & Isik, 2006; Havrylchyk, 2006; Sufian, 2009; Dong, 2010).

Market share (MS) is found to have a positive coefficient of 7.08 at the 1% statistically significant suggesting that higher market share increases total cost. According to the predicted negative and statistically significant coefficient (2.8) for the Herfindahl-Hirschman Index (HHI), banks with

more market dominance can considerably and negatively affect overall costs at the 1% level of significance.

Determinants of Inefficiency

It is assumed in the inefficiency effects model that inefficiency component u_{it} is positive, which means that more bank inefficiency is linked to higher costs. It is obvious that a positive co-efficient value causes the bank's cost inefficiency to rise (and vice versa). In Table 1, the findings of the maximum likelihood estimation of the parameters of the inefficiency effects model are shown.

The largest bank's size increases cost inefficiency, which causes a decline in cost efficiency, according to the maximum likelihood estimates of the co-efficient of size, which are positive (0.07) and significant at the 1% significance level. Banks with larger size suffer from bureaucratic problems which causes a decline in cost efficiency (Girardone et al., 2004; Dacanay, 2007).

It has been discovered that the financial intermediation ratio (FIR) significantly raises bank charges with negative coefficient of 1.03 at the 1% statistically significant suggesting that higher financial intermediation ratio reduces cost inefficiency and thereby reduces total cost (Fries &Taci, 2005; and Robin (2015).

The positive coefficient of liquidity ratio (1.30) indicates a positive relation with cost inefficiency which implies that greater liquidity ratio increases banks' costs enhancing cost inefficiency. We find a strong positive impact of GDP rate on cost inefficiency with a coefficient of 1.90 implying that rising GDP impacts cost efficiency negatively. An economy with higher growth increases demand for funds pushing borrowing costs up. According to Maudos et al. (2002), banks may become less cost-effective as a result of decreased pressure to reduce expenses as a result of rising demand. Although small, inflation is also proven to have a favorable effect on cost inefficiency.

The influence from dummy variable 'Global Financial Crisis (GFC)' on cost efficiency is found to be statistically insignificant due to limited exposure of the Bangladesh financial sector to international financial market is limited, we find an insignificant impact of Global Financial Crisis (GFC) on cost efficiency. Another dummy variable 'Bangladesh stock market crash

(SMC)' in 2011 has a significant impact on cost efficiency which may be attributed to fall in cost of funds following transfer of funds from share markets to the banking sector.

The computed sigma square's (σ2) coefficient, which measures goodness of fit, is positive (0.09) and statistically significant at the 1% level. The MLE stochastic cost frontier's gamma (γ) value is equal to 0.0006, which, at the 1% level of significance, is statistically significant. This shows that random error terms (vit) are responsible for 99.94% of the variation in the composite error term (uit+vit). It also indicates that much of difference between minimum cost and observed cost is due to external factors instead of inefficiency effects.

Model Specification Test

Now we will present the results of Model Specification Test (Table 2).

According to the first null hypothesis, the translog stochastic cost frontier model is insufficient when compared to the Cobb-Douglas stochastic cost frontier model. At the 1% level of significance, the first null hypothesis is strongly rejected, (H_0: $\beta_{11} = \beta_{22} = \beta_{33} = \beta_{44} = \beta_{55} = \beta_{66} = B_{77} = \beta_{12} = \beta_{13} = \beta_{14} = \beta_{15} = \beta_{16} = \beta_{17} = \beta_{23} = \beta_{24} = \beta_{25} = \beta_{26} = \beta_{27} = \beta_{34} = \beta_{35} = \beta_{36} = \beta_{37} = \beta_{45} = \beta_{46} = \beta_{47} = \beta_{56} = \beta_{57} = \beta_{67} = 0$) is strongly indicating that the translog stochastic cost frontier model is preferable to the Cobb-Douglas cost model for parameter estimation.

Table 1: Maximum Likelihood Estimates of Parameters of Inefficiency Effects Model

Variables	Symbols	Parameters	Coefficients	S.E	t-ratio
Constant		δ0	-0.0186	0.1067	-0.1739
Bank's size	Size	δ_1	0.0707***	0.0243	2.9164
Financial Intermediation Ratio	FIR	δ_2	-1.0395***	0.1243	-8.3642
Liquidity	LIQ	δ_3	1.3092***	0.1727	7.5809
GDP rate	GDP	δ_4	1.9017**	0.8444	2.2522
Inflation Rate	INF	δ_5	0.6190	1.0213	0.6060
Global Financial Crisis	GFC	δ_6	-0.0107	0.0708	-0.1504
Stock Market Crash	SMC	δ_7	-0.1678***	0.0289	-5.8123
Sigma-squared	$\sigma_s^2 = \sigma_v^2 + \sigma_u^2$		0.0906***	0.0080	11.2788
Gamma	$\gamma = \sigma_u^2 / \sigma_s^2$		0.0006***	0.0001	8.5394

Source: Estimation by the author using Computer Program FRONTIER version 4.1 developed by Coelli (1996)
Note: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively.

The second null hypothesis claims that the cost model does not have any inefficiency implications (H_0: $\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$). At a 1% level of significance, the second null hypothesis is rejected, indicating that the model has inefficiency effects. Additionally unpredictable and dynamic, these inefficiency impacts fluctuate with time. The calculated coefficient for variance parameter (gamma) is 0.0006, which means that at the 1% level of significance, inefficiency effects account for 0.06 percent of the composite error term ($v_{it} + u_{it}$)

The third null hypothesis is that environmental and control factors chosen for the inefficiency function does not have linear impacts on inefficiency (H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$). The final null hypothesis is also disproved at the 1% level of significance, indicating that inefficiency effects are linear function of control and environmental variables selected for the inefficiency function.

Table 2: Results of LR Test of Stochastic Cost Frontier Model Hypotheses

Null Hypothesis	Log-likelihood Function	Test statistic (γ)	Critical value (γ_c)	Decision
Cobb-Douglas Stochastic Cost Function	-32.44	342.75*	47.67	Reject H_0
No Inefficiency Effects	-229.99	30.80*	17.76	Reject H_0
No Joint Inefficiency Effect	-71.70	68.67*	17.76	Reject H_0

Note: The test statistics' critical values are all evaluated at the 1% level of significance.
*indicates mixed chi-square (χ^2) distribution (Kodde and Palm, 1986).
Source: Author's estimates

Efficiency of Islamic Commercial Banks in Bangladesh

Shahjalal Bank Limited came in first place overall with a score of 0.934. Al Arafah Islami Bank Limited came in second with a score of 0.933, followed by Social Islami Bank Limited (0.875), EXIM Bank Limited (0.812), and Islami Bank Bangladesh Limited (0.689) among the five Islamic banks in the sample. Table-3 depicts mean cost efficiency score and inefficiency of Islamic commercial banks during 2005-2018. All Islamic Banks have cost inefficiencies ranging from 6.6 percent to 31.1 percent, which means they might save enough money by using less resources to produce the same amount of output.

Table 3: Cost Efficiency of Islamic Commercial Banks (2005-2018)

Islamic Banks	Mean Cost Efficiency Score	Mean inefficiency Score	Rank
SJIBL	0.934	0.066	1
AIBL	0.933	0.067	2
SIBL	0.875	0.125	3
EXIM Bank Limited	0.812	0.188	4
IBBL	0.689	0.311	5

Source: Compiled by the author using Computer Program, FRONTIER Version 4.1

Table 1, Table 2, Table 3, and Table 4 in Appendix III provide the detailed cost efficiency of sample Islamic banks and State-owned, private, and foreign traditional banks from 2005 to 2018. Tables 1, 2, and 3 in Appendix IV show the mean cost efficiency of sample State-owned, private, and foreign conventional banks from 2005 to 2018.

Table 4 Relative Efficiency of State-owned, Traditional Private and Islamic Banks, 2005-18

Banks	Mean Cost Efficiency Score	Mean Cost inefficiency (%)
Islamic Commercial Banks	0.849	0.151
State Owned Commercial Banks	0.781	0.219
Private Commercial Banks	0.879	0.121
Foreign Commercial Banks	0.969	0.031
Mean	0.870	0.130

Source: Computed by the author using the FRONTIER version 4.1 computer program.

Comparison between Cost Efficiency of Islamic Banks and Other Traditional Banks

According to the relative research, Islamic commercial banks outperformed State-owned commercial banks (0.781) in terms of mean cost efficiency (0.849) but performed less well when compared to private banks (0.879) and international banks (0.969). Table 4 is an illustration of a relative position.

The better performance of Islamic banks against state banks is attributed to lower non-performing investment and higher financial

intermediation ratio. In case of cost efficiency, Islamic banks lagged behind private and foreign commercial banks due to higher cost of funds and less scope of investment. Islamic banks suffer from excess liquidity due to paucity of Shariah compliant short term and long-term securities and as results they face a low level of efficiency. Baten and Begum (2014) and Srairi (2010) found a low level of cost efficiency in Bangladesh and Gulf cooperation council (GCC) countries.

Results and Discussions on Performance Measures based on Maqasid al-Shariah (PMMS)

The current sub-section will analyze results on performance of Islamic banks during 2005-2018 using PMMS. To assess the performance of Islamic banks from the perspective of the Maqasid al Shariah, ten performance ratios are estimated as per Table 1 of Appendix V. Based on performance ratios, three Performance Indicators (PIs) are derived. Appendix VI contains information on three performance metrics for three Shariah objectives.

Relative Performance of Islamic Banks based on Maqasid Index (MI)

Now the study applies the Maqasid Index (MI) to assess the comparative performance of Bangladeshi Islamic banks from 2005 to 2008. Table 5 shows the three Performance Indicators based on three Shariah objectives and the Maqasid Index for each sample Islamic bank. IBBL achieved the top spot with a score of 23.07%, followed by SJIBL (22.76%), EXIM (21.46%), SIBL (20.77%), and AAIBL (19.16%).

Table 5: Three Performance Indicators and the Maqasid Index of Islamic Banks (2005–18)

Islamic Banks	PI (O1) (%)	PI (O2) (%)	PI (O3) (%)	MI= PI(O1)+ PI(O2)+ PI(O3)	Rank
IBBL	0.34	16.28	6.45	23.07%	1
AIBL	0.39	15.70	3.07	19.16%	5
SIBL	0.66	15.91	4.20	20.77%	4
EXIM	0.55	15.71	5.19	21.46%	3
SJIBL	0.27	15.83	6.66	22.76%	2

Note: First, second, and third performance indicators are designated by PI (O1), PI (O2), and PI(O3).
Source: Based on information gathered from each sample bank and compiled by the author

Comparative Performance of Islamic Banks Based on SFA Score and PMMS Score

Now the study compares the performance of sample Islamic banks based on cost efficiency and Maqasid Index using two models namely the SFA model and the PMMS model. Table 6 compares Islami banks' scores based on cost efficiency and the Maqasid Index.

Table 6: SFA and Maqasid Index-Based Comparison of Islamic Bank Performance, 2005–18

	SFA Score and Ranking		PMMS and ranking	
	SFA Score (%)	Ranking	Maqasid index (%)	Ranking
IBBL	68.90	5	23.07	1
AAIBL	93.35	2	19.16	5
SIBL	87.46	3	20.77	4
EXIM	81.24	4	21.46	3
SJIBL	93.43	1	22.76	2

Table 6 reveals that IBBL obtains the highest position in terms of Maqasid Index (23.07) but lowest score in case of cost efficiency based on SFA (68.90%). AAIBL fifth second position in terms of Maqasid Index (19.16) but second position in case of cost efficiency based on SFA (93.35%). SIBL attains fourth position in terms of Maqasid Index (20.77) but third position in case of cost efficiency based on SFA (87.46%). EXIM ranks third in terms of Maqasid Index (21.46) but fourth in terms of cost efficiency based on SFA (81.24%). SJIBL stands second in terms of Maqasid Index (22.76) but first in case of cost efficiency based on SFA (93.43%).

Recommendations

Based on the findings from the SFA model, the results suggest policy inputs for regulators, policy makers and managers of all Islamic for promoting cost efficiency which include economizing operating costs relating to financing and staff management, seeking low-cost funds, capitalizing banks adequately, making more investment in cost saving technologies, containing non-performing investment/loan, suggesting for not too big bank, superior management for banks, monitoring large size banks closely, raising financial intermediation ratio by state-owned banks

and undertaking right decisions in business operations under macroeconomic conditions with high GDP and inflation.

According to the Maqasid Index (MI), Islamic banks perform poorly, yet from the perspective of the Maqasid Al Shariah, there is plenty of space for development. Based on empirical findings, the results suggest increasing funding for Islamic finance in education, research, training, and public awareness, boosting the development of microfinance and ideal Islamic partnership modes like the Mudaraba and Musharaka, maintaining sustainability in terms of profitability with the goal to protect depositors' interests, a key source of funds, and expanding additional investments in real sectors for boosting GDP and creating more jobs for the younger generation.

As Islamic banks have attained divergent trend between cost efficiency and Maqasid index, there is much room for performance improvement in cost efficiency and higher scope for performance improvement in Maqasid Index.

CONCLUSIONS

The current study employs the parametric Stochastic Frontier Approach (SFA) and Performance Measures based on Maqasid al Shariah (PMMS) model to empirically analyze the performance of Bangladeshi Islamic commercial banks based on cost efficiency and the Maqasid index from 2005–2018.

Under the SFA, the average cost efficiency score of Islamic and state, private and foreign traditional commercial banks were 0.849, 0.781, 0.879 and 0.969 respectively. The average cost inefficiency score of Islamic and state, private and foreign traditional commercial banks were 0.151, 0.219, 0.121 and 0.031 respectively. Between 2005 and 2018, Islamic commercial banks achieved a mean cost efficiency score of 0.849 and a mean cost inefficiency score of 0.151. Accordingly, it follows that Islamic commercial banks can use less resources while yet delivering the same amount of output. As per the PMMS model, Bangladesh Islamic banks showed poor performance during 2005-2018. IBBL attains score of 23.07% followed by SJIBL (22.76%), EXIM (21.46%), SIBL (20.77%) and AAIBL (19.16%).

Islamic banks operate in order to attain twin objectives of achieving economic (cost) efficiency and ensuring welfare of the society. From theoretical perspective, the current study adds new dimension to performance analysis of Islamic banks by applying economic (cost) efficiency and welfare issues simultaneously. Thus, the novelty of the current study lies in measuring performance of Islamic banks from two dimension- economic (cost) efficiency and welfare issues. From a methodological viewpoint, the study also contributes greatly to measure performance of Islamic banks by using two models-Stochastic Frontier Analysis (SFA) and Performance Measures based on Maqasid al Shariah (PMMS).

The current article makes significant policy contributions for regulators, policy makers, managers and customers of commercial banks. Firstly, it provides determinants of efficiency of commercial banks. Secondly, the article provides vital information on performance gaps from the viewpoint of cost efficiency and welfare issues. Thirdly, regulators, policy makers and managers can adopt necessary policy actions to improve performance of Islamic commercial banks from perspective of cost efficiency and welfare issue.

The study has some limitations. Firstly, it uses only cost efficiency to measure performance. Second, it applies only one model, the Stochastic Frontier Analysis (SFA) to measure cost efficiency. Thirdly, the Performance Measures based on Maqasid al Shariah (PMMS) model considers only three Shariah objectives namely education, justice and welfare.

Future research may take into account some key issues namely application of profit efficiency side by side cost efficiency, the adoption of two methods (Stochastic Frontier Analysis-SFA and Data Envelopment Analysis-DEA) rather than one method for methodological cross-checking, and the addition of a fourth objective, financial stability objective to the current three Shariah objectives under Performance Measures based on Maqasid al Shariah (PMMS) model for addressing investment risk as measured by non-performing assets and promoting sustainable finance for addressing environmental issues.

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APPENDIX I

Definitions of Different Bank's Variables	
Variables	**Descriptions**
Dependent variables	
Total Costs (TC)	Profit/interest, Staff salaries and other operating costs (BDT)*
Independent Variables	
Outputs	
Total investments (q_1) **	The value of total investment (BDT)
Other Earning Assets (q_2)	The value of total other earning assets (BDT)
Off-balance Sheet Items (q_3)	The value of total Off-balance Sheets Items (BDT)
Input Prices	
Price of Deposits (P_1)	Total Profit/interest /Total Deposits
Price of Staff (P_2)	Total Personal Expenses/Total Number of Staffs
Price of Fixed Assets (P_3)	Total expenses(depreciations) on premises and fixed assets/Total Fixed assets
Control and Environmental Variables	
Equity Capital	Total Paid-up capital
Time Tend (t)	t=2005, ……,T=14 for 2018
Risk	Non-Performing Loan/Investment (NPL)
Market Share (MS)	Ratio of Assets to Total Assets of Entire Industry
Herfindahl-Hirschman Index (HHI)***	Sum of the squared assets of all banks
Global Financial Crisis (GFC)	Dummy Variable forGlobal Financial Crisis (GFC)of 2008
Share Market Crash (SMC)	Dummy Variable forShare Market Crash (SMC)in 2011
Size	Log of Total Assets
Financial Intermediation Ratio (FIR)	Ratio of Total Loans to Total Deposits
Liquidity	Ratio of Total Loans to Total Assets
Gross Domestic Product (GDP)	Yearly GDP Growth Rate (%) in Bangladesh
Annual Inflation	Annual Inflation rate (%) in Bangladesh

Source: Based on literatures relating to financial intermediation approach
*BDT=Bangladesh Taka (Currency) **Traditional bank's loan/advances ***It measures Market Concentration

Maximum Likelihood Estimates (MLE) of Translog Stochastic Cost Frontier Model					
Variables	**Symbols**	**Parameters**	**Coefficients**	**S.E**	**t-ratio**
Constants	Intercept	β_0	0.1043	0.1546	0.6748
Investments	lnq_1	β_1	0.6729***	0.1445	4.6562
Other Earning asset	lnq_2	β_2	-0.1440**	0.0580	-2.4839
Off-Balance Sheet Items	lnq_3	β_3	0.0776	0.0949	0.8184
Price of Deposits	lnP_1/P_3	β_4	0.6409***	0.0862	7.4311
Price of Staff	lnP_2/p_3	β_5	0.2265**	0.0915	2.4770
Equity Capital (EC)	lnz_1	β_6	-0.1806**	0.0792	-2.2793
Time	t	B_7	0.0113	0.0240	0.4721
0.5Investments^2	$0.5lnq_1^{\wedge 2}$	β_{11}	-0.1878*	0.1045	-1.7978
0.5 Other Earning Assets^2	$0.5lnq_2^{\wedge 2}$	β_{22}	-0.0521***	0.0161	-3.2352
0.5 Off-Balance Sheet Items^2	$0.5lnq_3^{\wedge 2}$	β_{33}	-0.0213	0.0349	-0.6088
0.5 Price of Deposits^2	$0.5\ (lnp_1/P_3)^{\wedge 2}$	β_{44}	0.0405	0.0438	0.9235
0.5 Price of Staff^2	$0.5\ (lnp_2/P_3)^{\wedge 2}$	β_{55}	0.0254	0.0508	0.5011
0.5 Equity Capital^2	$0.5\ (lnz_1)^{\wedge}2$	β_{66}	0.1532**	0.0633	2.4211
0.5 Time^2	$0.5t^2$	B_{77}	0.0002	0.0031	0.0754
Investments x Other Earning Assets	lnq_1lnq_2	β_{12}	-0.0350	0.0439	-0.7979
Investments x Off-Balance Sheet Items	lnq_1lnq_3	β_{13}	0.1197**	0.0586	2.0431
Investments x Price of Deposits	$lnq_1ln(P_1/p_3)$	β_{14}	0.0909**	0.0409	2.2212
Investments x Price of Staff	$lnq_1ln(P_2/p_3)$	β_{15}	0.0689	0.0422	1.6330
Investments x Equity Capital	lnq_1lnz_1	β_{16}	-0.3543***	0.1030	-3.4402
Investments x time	lnq_1t	β_{17}	-0.0422***	0.0117	-3.6101
Other Earning Assets x Off-Balance Sheet Items	lnq_2lnq_3	β_{23}	0.0261	0.0252	1.0328
Other Earning Assets x Price of Deposits	$lnq_2ln(P_1/p_3)$	β_{24}	-0.1632***	0.0343	-4.7532
Other Earning Assets x Price of Staff	$lnq_2ln(P_2/p_3)$	β_{25}	0.0165	0.0399	0.4144
Other Earning assets x Equity Capital	lnq_2lnz_1	β_{26}	0.0432	0.0449	0.9626
Other Earning Assets x time	lnq_2t	β_{27}	0.0387***	0.0057	6.7891
Off-Balance Sheet Items x Price of Deposits	$lnq_3ln(P_1/p_3)$	β_{34}	-0.0229	0.0351	-0.6520
Off-Balance Sheet Items x Price of Staff	$lnq_3ln(P_2/p_3)$	β_{35}	0.0538	0.0349	1.5433
Off-Balance Sheet Items x Equity Capital	lnq_3lnz_1	β_{36}	0.0291	0.0522	0.5583
Off-Balance Sheet Items x time	lnq_3t	β_{37}	-0.0099	0.0083	-1.1893
Price of Deposits x Price of Staff	$ln(p_1/p_3)ln(P_2/p_3)$	β_{45}	-0.0187	0.0292	-0.6399
Price of Deposits x Equity Capital	$ln(p1/p_3)lnz_1$	β_{46}	0.0259	0.0562	0.4602
Price of Deposits x time	$ln(p1/p_3)t$	β_{47}	-0.0082	0.0098	-0.8384
Price of Staff x Equity Capital	$ln(p_2/p_3)lnz_1$	β_{56}	-0.0425	0.0563	-0.7543
Price of Staff x time	$ln(p_2/p_3)t$	β_{57}	0.0102	0.0098	1.0344
Equity Capital x time	lnz_1t	β_{67}	0.0170**	0.0083	2.0363
Non-performing Loan	NPL	τ_1	0.1426***	0.0357	4.0006
Market Share	MS	τ_2	7.0820***	1.0468	6.7656
Herfindahl-Hirschman Index	HHI	τ_3	-2.8401***	0.9960	-2.8515

Source: Estimation by the author using Computer Program FRONTIER version 4.1 developed by (Coelli, 1996)
Notes: (i) Investments of Islamic Bank denote loans /advances in case of traditional bank
(ii) ***, ** and * indicate 1%, 5% and 10% significance levels, respectively.

APPENDIX II

Maximum Likelihood Estimates (MLE) of Translog Stochastic Cost Frontier Model					
Variables	**Symbols**	**Parameters**	**Coefficients**	**S.E**	**t-ratio**
Constants	Intercept	β_0	0.1043	0.1546	0.6748
Investments	lnq_1	β_1	0.6729***	0.1445	4.6562
Other Earning asset	lnq_2	β_2	-0.1440**	0.0580	-2.4839
Off-Balance Sheet Items	lnq_3	β_3	0.0776	0.0949	0.8184
Price of Deposits	lnP_1/P_3	β_4	0.6409***	0.0862	7.4311
Price of Staff	lnP_2/p_3	β_5	0.2265**	0.0915	2.4770
Equity Capital (EC)	lnz_1	β_6	-0.1806**	0.0792	-2.2793
Time	t	B_7	0.0113	0.0240	0.4721
0.5Investments^2	$0.5lnq_1^{\wedge 2}$	β_{11}	-0.1878*	0.1045	-1.7978
0.5 Other Earning Assets^2	$0.5lnq_2^{\wedge 2}$	β_{22}	-0.0521***	0.0161	-3.2352
0.5 Off-Balance Sheet Items^2	$0.5lnq_3^{\wedge 2}$	β_{33}	-0.0213	0.0349	-0.6088
0.5 Price of Deposits^2	$0.5 (lnp_1/P_3)^{\wedge 2}$	β_{44}	0.0405	0.0438	0.9235
0.5 Price of Staff^2	$0.5 (lnp_2/P_3)^{\wedge 2}$	β_{55}	0.0254	0.0508	0.5011
0.5 Equity Capital^2	$0.5 (lnz_1)^{\wedge}2$	β_{66}	0.1532**	0.0633	2.4211
0.5 Time^2	$0.5t^2$	B_{77}	0.0002	0.0031	0.0754
Investments x Other Earning Assets	lnq_1lnq_2	β_{12}	-0.0350	0.0439	-0.7979
Investments x Off-Balance Sheet Items	lnq_1lnq_3	β_{13}	0.1197**	0.0586	2.0431
Investments x Price of Deposits	$lnq_1ln(P_1/p_3)$	β_{14}	0.0909**	0.0409	2.2212
Investments x Price of Staff	$lnq_1ln(P_2/p_3)$	β_{15}	0.0689	0.0422	1.6330
Investments x Equity Capital	lnq_1lnz_1	β_{16}	-0.3543***	0.1030	-3.4402
Investments x time	lnq_1t	β_{17}	-0.0422***	0.0117	-3.6101
Other Earning Assets x Off-Balance Sheet Items	lnq_2lnq_3	β_{23}	0.0261	0.0252	1.0328
Other Earning Assets x Price of Deposits	$lnq_2ln(P_1/p_3)$	β_{24}	-0.1632***	0.0343	-4.7532

Other Earning Assets x Price of Staff	$\ln q_2 \ln(P_2/p_3)$	β_{25}	0.0165	0.0399	0.4144
Other Earning assets x Equity Capital	$\ln q_2 \ln z_1$	β_{26}	0.0432	0.0449	0.9626
Other Earning Assets x time	$\ln q_2 t$	β_{27}	0.0387***	0.0057	6.7891
Off-Balance Sheet Items x Price of Deposits	$\ln q_3 \ln(P_1/p_3)$	β_{34}	-0.0229	0.0351	-0.6520
Off-Balance Sheet Items x Price of Staff	$\ln q_3 \ln(P_2/p_3)$	β_{35}	0.0538	0.0349	1.5433
Off-Balance Sheet Items x Equity Capital	$\ln q_3 \ln z_1$	β_{36}	0.0291	0.0522	0.5583
Off-Balance Sheet Items x time	$\ln q_3 t$	β_{37}	-0.0099	0.0083	-1.1893
Price of Deposits x Price of Staff	$\ln(p_1/p_3)$ $\ln(P_2/p_3)$	β_{45}	-0.0187	0.0292	-0.6399
Price of Deposits x Equity Capital	$\ln(p1/p_3)\ln z_1$	β_{46}	0.0259	0.0562	0.4602
Price of Deposits x time	$\ln(p1/p_3)t$	β_{47}	-0.0082	0.0098	-0.8384
Price of Staff x Equity Capital	$\ln(p_2/p_{3)}\ln z_1$	β_{56}	-0.0425	0.0563	-0.7543
Price of Staff x time	$\ln(p_2/p_3)t$	β_{57}	0.0102	0.0098	1.0344
Equity Capital x time	$\ln z_1 t$	β_{67}	0.0170**	0.0083	2.0363
Non-performing Loan	NPL	τ_1	0.1426***	0.0357	4.0006
Market Share	MS	τ_2	7.0820***	1.0468	6.7656
Herfindahl-Hirschman Index	HHI	τ_3	-2.8401***	0.9960	-2.8515

Source: Estimation by the author using Computer Program FRONTIER version 4.1 developed by (Coelli, 1996)
Notes: (i) Investments of Islamic Bank denote loans /advances in case of traditional bank
(ii) ***, ** and * indicate 1%, 5% and 10% significance levels, respectively.

APPENDIX III

Table 1: Trend of Cost Efficiency of Islamic Commercial Banks (2005-2018)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
IBBL	0.663	0.643	0.645	0.753	0.682	0.655	0.843	0.647	0.692	0.681	0.691	0.670	0.691	0.691
AAIBL	0.993	0.941	0.953	0.967	0.987	1.000	1.000	0.885	0.837	0.847	0.935	0.939	0.956	0.828
SIBL	0.885	0.890	0.797	0.903	0.961	0.922	1.000	0.857	0.890	0.872	0.833	0.808	0.802	0.823
EXIM	0.827	0.827	0.849	0.806	0.811	0.810	0.988	0.789	0.799	0.765	0.778	0.763	0.762	0.801
SJIB	0.892	0.864	0.909	0.889	0.912	0.899	1.000	0.907	0.981	0.949	0.929	0.985	0.998	0.966
Mean	0.852	0.833	0.831	0.864	0.871	0.857	0.966	0.817	0.840	0.823	0.833	0.833	0.842	0.822

Table 2. Trend of Cost Efficiency of State-owned Commercial Banks (2005-2018)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SB	0.656	0.604	0.763	0.764	0.791	0.764	0.937	0.734	0.738	0.711	0.709	0.683	0.692	0.705
JB	0.614	0.653	0.712	0.723	0.759	0.876	1.000	0.736	0.756	0.748	0.742	0.732	0.754	0.771
AB	0.733	0.709	0.845	0.803	0.836	0.832	0.999	0.807	0.811	0.815	1.000	0.785	0.790	0.770
RB	0.712	0.712	0.736	0.794	0.846	0.934	1.000	0.861	0.834	0.818	0.799	0.795	0.788	0.760
Mean	0.679	0.670	0.764	0.771	0.808	0.852	0.984	0.785	0.785	0.773	0.812	0.749	0.756	0.751

Table 3. Trend of Cost Efficiency of Private Commercial Banks (2005-2018)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Pubali	0.7969	0.7986	0.8181	0.8277	0.8451	0.8500	0.9981	0.8520	0.8740	0.8711	0.8549	0.8676	0.9117	0.8738
AB	0.8528	0.7685	0.7959	0.8298	0.9025	0.9988	1.0000	0.8295	1.0000	0.8711	0.9181	0.8669	0.9128	0.9360
NBL	0.7987	0.7812	0.7958	0.8188	0.8405	0.9312	1.0000	0.8673	0.8174	0.8537	0.8589	0.8533	0.8611	0.8511
City	0.8009	0.8182	0.8340	0.9432	0.8853	0.9202	1.0000	0.9603	0.9718	0.9990	1.0000	1.0000	0.9990	1.0000
IFIC	0.9644	0.8883	0.9474	0.9110	0.9211	0.8764	0.9990	0.8572	0.8492	0.8453	0.8586	0.8684	0.8693	0.8401
UCBL	0.8235	0.7099	0.8984	0.8219	0.8174	1.0000	0.9782	0.7946	0.9625	0.8712	0.8998	0.8541	0.8756	0.8988
DBBL	0.8381	0.7736	0.8102	0.8161	0.8628	0.8520	0.9963	0.8404	0.8850	0.8873	0.8920	0.9052	0.9047	0.8794
Prime	0.7728	0.7078	0.7096	0.8299	0.7864	0.9159	0.9913	0.8530	0.8105	0.8393	0.8848	0.8890	0.9789	0.9981
Southeast	0.7516	0.7904	0.7568	0.7890	0.7990	0.8185	0.9957	0.8213	0.8793	0.8743	0.8365	0.8529	0.8378	0.8390
BRAC	0.9424	0.9348	0.8604	0.8597	0.9044	0.9972	0.9990	0.8696	0.9890	0.9621	1.0000	0.9969	0.9094	0.8074
Mean	0.8342	0.7971	0.8227	0.8447	0.8564	0.9160	0.9958	0.8545	0.9039	0.8874	0.9004	0.8954	0.9060	0.8924

Table 4. Trend of Cost Efficiency of Foreign Commercial Banks (2005-2018)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SCB	0.832	0.797	0.863	0.882	0.931	0.983	0.778	0.920	0.911	0.965	0.963	0.938	0.941	0.851
CITI	0.950	0.905	0.927	0.921	0.990	1.000	1.000	1.000	1.000	0.999	0.999	0.999	1.000	0.999
HSBC	1.000	1.000	0.999	0.998	1.000	1.000	1.000	1.000	0.963	0.987	0.995	0.995	0.996	0.980
SBI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Habib	1.000	1.000	1.000	1.000	0.667	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mean	0.956	0.940	0.958	0.960	0.918	0.997	0.956	0.984	0.975	0.990	0.991	0.986	0.987	0.966

APPENDIX IV

Table 1: Cost Efficiency of State-owned Commercial Banks (2005-2018)

SCBs	Mean Cost Efficiency Score	Mean Cost Inefficiency Score	Rank
Agrani	0.824	0.176	1
Rupali	0.814	0.186	2
Janata	0.755	0.245	3
Sonali	0.732	0.268	4

Source: Compiled by the author using Computer Program, FRONTIER Version 4.1

Table 2: Cost Efficiency of Traditional Private Commercial Banks (2005-2018)

CPCBs	Mean Cost Efficiency Score	Mean Cost Inefficiency (%)	Rank
City	0.938	0.062	1
BRAC	0.931	0.069	2
AB	0.892	0.108	3
IFIC	0.893	0.107	4
UCBL	0.872	0.128	5
Dutch-Bangla	0.867	0.133	6
Pubali	0.860	0.140	7
Prime	0.855	0.145	8
NBL	0.852	0.148	9
Southeast	0.832	0.168	10

Source: Compiled by the author using Computer Program, FRONTIER Version 4.1

Table 3: Cost Efficiency of Foreign Commercial Banks (2005-2018)

FCBs	Mean Cost Efficiency Score	Mean Cost Inefficiency (%)	Rank
SCB	0.897	0.103	5
SBI	1.000	0.000	1
HSBC	0.994	0.006	2
CITI	0.978	0.022	3
Habib	0.976	0.024	4

Source: Compiled by the author using Computer Program, FRONTIER Version 4.1

APPENDIX V

Table 1: Objectives, Dimensions, Elements and Performance Ratio

Concepts (Objectives)	Dimensions (D)	Elements (E)	Performance Ratios
1.Educating Individual	D_1. Advancement of Knowledge	E_1. Education grant	R_1. Education grant/total expense
		E_2. Research	R_2. Research expense/ total expense
	D_2. Instilling new skills and improvements	E_3. Training	R_3. Training expense/ total expense
	D_3. Creating Awareness of Islamic Banking	E_4. Publicity	R_4. Publicity expense/ total expense
2. Establishing Justice	D_4. Empowering the Poor	E_5. Supporting Microfinance	R_5. Investments in Microfinance/ total investments
	D_5. Cheap products and services	E_6. Functional Distribution	R_6. Investments in Mudarabah and Musharakah modes/ total investment
	D_6. Elimination of injustices	E_7. Interest Free product	R_7. Interest free income/total income
3. Public welfare	D_7. Profitability	E_8. Profit ratios	R_8. Net profit/ total asset
	D_8. Redistribution of income & wealth	E_9. Personal income transfer	R_9. Zakah/ Net Assets
	D_9. Investment in real sector	E_{10}. Investment ratio in real sector	R_{10}. Investment in real sector / total Investment

Source: Mustafa et al., (2008 & 2010) with some modifications

Table 2: Weights of Objectives and Elements

Objectives	Weight (Out of 100)	Element	Weight (Out of 100)
1. Educating Individual	30	E_1. Education grant	24
		E_2. Research	27
		E_3. Training	26
		E_4. Publicity	23
		Total	100
2. Establishing justice	41	E_5. Supporting Microfinance	30
		E_6. Functional Distribution	32
		E_7. Interest free product	38
		Total	100
3. Public welfare	29	E_8. Profit ratios	33
		E_9. Personal income transfer	30
		E_{10}. Investment ratios in real sector	37
Total	100	Total	100

Source: Mustafa et al. (2008)

APPENDIX VI

Table 1: Performance Indicator of First Shariah Objective, Education (2005-18)

Elements	IBBL	AIIBL	SIBL	EXIM	SJIBL
Education grants (%)	0.07	0.10	0.18	0.11	0.15
Research grants (%)	0.02	0.00	0.00	0.00	0.00
Training expenses (%)	0.08	0.14	0.23	0.15	0.23
Publicity Expenses (%)	0.17	0.15	0.25	0.30	0.27

Source: Compiled by the author based on data collected from each sample bank

Table 2: Performance Indicator of Second Shariah Objective, Justice (2005-18)

Elements	IBBL	AIIBL	SIBL	EXIM	SJIBL
Investment in Microfinance (%)	0.41	0.12	0.27	0.13	0.25
Investments in Mudarabah and Musharakah (%)	0.33	0.00	0.06	0.00	0.00
Interest free income (%)	15.58	15.58	15.58	15.58	15.58

Source: Compiled by the author based on data collected from each sample bank

Table 3: Performance Indicator of Third Shariah Objective, Public Welfare (2005-18)

Elements	IBBL	AIIBL	SIBL	EXIM	SJIBL
Profit ratio (%)	0.14	0.15	0.08	0.14	0.13
Distribution of Wealth (Zakat) (%)	0.07	0.00	0.04	0.04	0.05
Investment in real sector (%)	6.25	2.91	4.08	5.01	6.48

Source: Compiled by the author based on data collected from each sample bank