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Opening the Black Box on Bank Efficiency in Bangladesh

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ABSTRACT

The paper examines internal (bank specific) and external (macro and market) determinants of profit efficiency in the Bangladesh banking sector. The analysis consists of two stages. In the first stage, Data Envelopment Analysis (DEA) method was employed to compute profit efficiency of 31 commercial banks operating in the Bangladesh banking sector during the period of 2004 to 2011. In the second stage, panel regression analysis was used to examine contextual factors influencing the productive efficiency of banks. It was found that credit risk, non-interest income and bank size negatively influenced bank profit efficiency. On the other hand, the findings indicate that lower (higher) liquidity has positive (negative) impacts on the profit efficiency of banks operating in the Bangladesh banking sector. Nonetheless, no statistically significant influence of ownership structures was found on bank profit efficiency. Likewise, Bangladesh banks seemed not to have been significantly affected by the global financial crisis. The paper could be extended to include more variables, the non-parametric Malmquist Productivity Index (MPI) method and production function, along with intermediation function. The findings from this study are expected to contribute significantly to regulators, bank managers, investors, and also the existing knowledge on the level of profit efficiency of the Bangladesh banking sector. The paper seeks to provide for the first time empirical evidence on the profit efficiency of the Bangladesh banking sector.

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INTRODUCTION

The banking sector is the main source of funds for long-term investments and

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the foundation of economic growth (Schumpeter, 1934). In any country, the banking sector represents the financial system's fundamental and the efficiency of the banking sector ensures an effective financial system. According to Levine (1998), the efficiency of financial intermediation affects a country's economic growth and at the same time, bank (financial intermediation) insolvencies could result in systemic crises resulting in negative implications on the economy.

The banking sector in Bangladesh has been one of the most important mechanisms of their financial system since the early 1970s. All the financial institutions, including commercial banks, are required to fulfil economic objectives set by the government. Basically, there are four types of banks operating in the Bangladesh banking sector: Government Owned Specialized Banks or State Owned Development Financial Institution (DFIs), Nationalized Commercial Banks or State Owned Commercial Banks (SCBs), Domestic Private Commercial Banks (PCBs) and Foreign Commercial Banks (FCBs).

The efficiency of the banking sector has become an imperative issue in Bangladesh since the formation of the National Commission on Money, Banking and Credit in 1986 (Shameem, 1995). The purpose for the establishment of the commission, among others, is to find solutions for efficient operations and management of the banking system (Shameem, 1995). Furthermore, in 1991 the World Bank also assisted the Central Bank of Bangladesh (CBB) to strengthen the country's banking sector regulation and supervision. In maintaining the stability of the banking system, the efficiency of the banking sector is important so as to ensure that banks remain profitable and healthy.

It could be argued that improvements in profit efficiency could lead to higher bank profitability levels and ensure sustainability of the country's economic growth (Sufian *et al*., 2013; Kamarudin *et al*., 2013; Kamarudin *et al*., 2014a; Kamarudin *et al*., 2014b). Furthermore, profit efficiency is also a firm's maximisation of profit since it takes into account both cost and revenue effects on the changes in outputs scale and scope. Profit efficiency measures how close a bank is in producing the maximum level of profits, given the amount of inputs and outputs and their price levels (Akhavein *et al*., 1997; Akhigbe & McNulty, 2003; Ariff & Can, 2008). Thus, profit efficiency provides a complete description on the economic goal of a bank which requires that banks reduce their costs and increase their revenues. Furthermore, Berger and Mester (2003) and Maudos and Pastor (2003), among others, suggest that profit efficiency offers valuable information on the efficiency of bank managements.

The paper seeks to provide for the first time empirical evidence, which is also known as investigate the "black box" on the profit efficiency of the Bangladesh banking sector using the frontier efficiency analysis approach, i.e. the non-parametric Data Envelopment Analysis (DEA). Although studies on bank efficiency are voluminous, they have mainly concentrated on the banking sectors of the western and developed countries. Thus, almost virtually nothing has been done to specifically investigate the profit efficiency of the Bangladesh banks which presents the most important efficiency concept since it may influence the profitability of the banks (Maudos *et al*., 2002; Ariff & Can, 2008). On the other hand, empirical evidence on developing countries is relatively scarce and majority of these studies focused on the technical, pure technical and scale efficiency concepts. To do so, a two-stage analysis was adopted in this study. In the first stage, the Data Envelopment Analysis (DEA) method was used to compute the profit efficiency of 31 commercial banks operating in the Bangladesh banking sector during the period 2004 – 2011 to encapsulate the most recent global financial crisis period. In the second stage, panel regression analysis was employed to examine the contextual factors such as the internal (bank specific) and external (macro and market) influencing the productive efficiency of banks.

The findings of this study will add to the current knowledge on the profit efficiency of the Bangladesh banking sector. Even though there has been widespread literature investigating efficiency of the banking sectors, the study on the specific profit efficiency concept of Bangladesh banks is still in its formative stage. This study attempts to fill this gap by extending the previous works on the efficiency of the banking sectors, specifically on the profit efficiency concept.

This study also attempts to identify the internal determinants of profit efficiency. The external determinants will also be taken into account to identify the factors that may influence profit efficiency at the macro level. By recognising all potential determinants, the factors that have the most influence on profit efficiency could be further examined. The findings of this study will be useful to several parties such as regulators, bank managers, investors and also to the existing knowledge on the operating performance of the Bangladesh banking sector.

The paper is set out as follows: the next section provides the related literature and hypotheses, followed by outlining the methodology and data in section 4. Section 5 reports on the empirical results of this study, and section 6 offers conclusions and avenues for future research.

REVIEW OF LITERATURE

The basic concept of efficiency is that it measures how well firms transform their inputs into outputs according to their behavioural objectives (Fare *et al*., 1994). A firm is said to be efficient if it is able to achieve its goals and inefficient if it fails. In normal circumstances, a firm's goal is assumed to be cost minimisation of production. Thus, any waste of inputs is to be avoided so that there is no idleness in the use of resources. In the production theory, it is often assumed that firms are behaving efficiently in an economic sense. According to Fare *et al*. (1985), firms are able to successfully allocate all resources in an efficient manner relative to the constraints imposed by the structure of the production technology, by the structure of input and output markets, and relative to whatever behavioural goals attributed to the producers.

A wide range of models have been used to investigate a spectrum of efficiency related issues in a wide range of environments. Koopmans (1951) was the first to provide the definition of technical efficiency, where producer is technically efficient if an increase in any output requires a reduction in at least one output and if a reduction in any input requires an increase in at least one other input or a reduction in at least an output. Meanwhile, Liebenstein (1966) was the first to introduce the concept of X-efficiency. The X-efficiency concept defines cost inefficiencies that are due to wasteful use of inputs or managerial weakness. The X-efficiency concept seeks to explain why all firms do not succeed in minimising the cost of production and recognises that the sources of X-efficiency may also be from outside of the firm. In this regard, Button and Jones (1992) suggested that X-inefficiency is partly due to firm's own actions, as well as exogenous factors surrounding the environment in which the firm is operates.

Berger and Mester (2003) have shown that separate evaluation of cost and revenue efficiency may not capture the goal of a bank which is to maximise profit. The profit efficiency concept helps to overcome the shortfall since its main goal is to maximise revenues and profit by minimising costs from various inputs and outputs. Technically, profit efficiency can be divided into two major types, namely; standard profit efficiency and alternative profit efficiency. Maudos *et al*. (2002) suggested that besides requiring that goods and services to be produced at a minimum cost, the measurement of profit efficiency require maximisation of revenues to match the profit maximisation objective. In essence, the wrong choice of outputs or the mispricing of outputs may result in revenue inefficiency.

Adongo *et al*. (2005) posited that profit efficiency occurs only if the costs rise from producing additional or higher quality services, but the increase in revenues should be higher than the increase in cost. Meanwhile, Ariff and Can (2008) suggested that the standard profit efficiency measure assumes the existence of perfect competition in both input and output factors. Their findings indicate that a bank is a price-taker, and this implies that it has no market power to determine the prices of output. On the other hand, the alternative profit efficiency assumes the existence of imperfect competition, where a bank is a price-setter, indicating that it has market power in setting the output prices.

Bader *et al*. (2008) pointed out that

there are a fair number of studies which have examined the efficiency of the banking sectors in developing countries. However, previous studies have mainly concentrated on the technical, pure technical and scale efficiency concept (see for example, Isik & Hassan, 2002; Sufian, 2009; Sufian & Habibulah, 2009). On the other hand, studies which investigated the cost, revenue, and profit efficiency are relatively scarce (e.g., Ariff & Can, 2008) and completely missing within the context of the Bangladesh banking sector. In the light of the knowledge gap, the present paper seeks to contribute to the literature by providing for the first time the empirical evidence on the profit efficiency of the Bangladesh banking sector.

HYPOTHESES DEVELOPMENT

The contextual variables used to explain the efficiency of banks in this study were grouped under two main categories. The first represents bank specific attributes, while the second encompasses economic and market conditions during the period examined. The bank specific variables included in the regression models were LN(LLR/GL) (log of loans loss reserves divided by gross loans), LN(ETA) (log of equity divided by total assets), LN(NII/TA) (log of non-interest income divided by total assets), LN(NIE/TA) (log of non-interest expenses divided by total assets), LN(LOANS/TA) (log of total loans divided by total assets) and LN(TA) (log of total assets).

Credit Risk[3] The LN(LLR/GL) variable was incorporated as the independent variable in the regression analysis as a proxy of credit risk. The coefficient of LLP/TL was expected to take a negative sign because bad loans reduced bank profitability and was consequently expected to exert negative influence on bank profit efficiency. In this direction, Miller and Noulas (1997) suggested that the greater financial institutions' exposure towards high risk loans, the higher the accumulation of unpaid loans resulting in a lower profitability would be.

H0: The relationship between credit risk and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables;

H1: The relationship between credit risk and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables.

Capitalization The LN(E/TA) variable was included in the regression models to examine the relationship between efficiency and bank capitalization. Strong capital structure is essential for banks in developing economies since it provides additional strength to withstand financial

[3]Laeven and Majnoni (2003) point out that economic capital should be tailored to cope with unexpected losses and loan loss reserves should instead buffer the expected component of the loss distribution. Consistent with this interpretation, loan loss provisions should be considered and treated as cost, which will be faced with certainty over time, but is uncertain as to when it will materialize.

crises and increase safety for depositors during unstable macroeconomic conditions (Sufian, 2009). Furthermore, lower capital ratios in banking imply higher leverage and risk, and therefore greater borrowing costs. Thus, relatively better capitalized banks should exhibit higher efficiency levels.

H0: The relationship between capitalization and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables;

H1: The relationship between capitalization and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

Diversification In order to recognise that financial institutions have been generating income from "off-balance sheet" business and fee income in recent years, the LN(NII/TA) variable was entered in the regression models as a proxy measure of bank diversification into non-traditional activities. Non-interest income consists of commission, service charges, and fees, guarantee fees, net profit from sale of investment securities and foreign exchange profit. The variable was expected to exhibit positive relationship with bank efficiency.

H0: The relationship between diversification and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables;

H1: The relationship between diversification and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

Operating Expenses The LN(NIE/TA) variable was used to provide information on the variation of bank operating costs. The variable represents total amount of wages and salaries, as well as costs of running branch office facilities. The relationship between the NIE/TA variable and bank profit efficiency levels may be negative, because the more efficient banks should keep their operating costs low. Furthermore, the usage of new electronic technology, like ATMs and other automated means of delivering services, may have caused expenses on wages to fall (as capital is substituted for labour).

H0: The relationship between operating expenses and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

H1: The relationship between operating expenses and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables.

Loans Intensity LN(LOANS/TA) as a proxy of loans intensity is expected to affect bank efficiency positively. However, the loan-performance relationship depends significantly on the expected change of the economy. During a strong economy, only a small percentage of loans will default and bank profitability would increase. On the other hand, the bank could adversely be affected during a weak economy, because borrowers are likely to default on their loans. Ideally, banks should capitalize on favourable economic conditions and insulate themselves during adverse conditions.

H0: The relationship between loans intensity and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables.

H1: The relationship between loans intensity and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

Size The LN(TA) variable is included in the regression models as a proxy of size to capture for possible cost advantages associated with size (economies of scale). In the literature, mixed relationships are observed between size and profitability, while some studies suggest a U-shaped relationship. LNTA is also used to control for cost differences relating to bank size and the ability of large banks to diversify. In essence, LNTA may lead to positive effect on bank efficiency if economies of scale are observed. On the other hand, if increased diversification leads to higher risks, the variable may exhibit negative effects.

H0: The relationship between size and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables.

H1: The relationship between size and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

Ownership To examine whether bank ownership exerts significant influence in determining the efficiency of banks operating in the Bangladesh banking sector, following Micco *et al*. (2007) among others, dummy variables DUMSCB (a binary dummy variable that takes a value of 1 for the state owned commercial banks, 0 otherwise) and DUMPCB (a binary dummy variable that takes a value of 1 for the Private Commercial Banks, 0 otherwise) are introduced in regression models IV and V, respectively. Micco *et al*. (2007) pointed out that the state owned commercial banks tend to be relatively inefficient compared to their private and foreign owned bank counterparts throughout the South Asian region. Therefore, the authors expected to find positive relationship between private ownership and bank efficiency under the null hypothesis.

H0: The relationship between private ownership and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables.

H1: The relationship between private ownership and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

Macroeconomic Conditions To measure the relationship between economic conditions and bank efficiency, LN(GDP) (log of Gross Domestic Products) and LN(INFL) (log of the rate of inflation) were included in the regression models. We did not have any priori expectations on both the LN(GDP) and LN(INFL) variables. Meanwhile, favourable economic conditions might have positive effect on both demand and supply of banking services, but would have either positive or negative influence on bank's profitability. Staikouras and Wood (2004) pointed out that inflation might have direct effects such as the increase in the price of labour and indirect effects like changes in interest rates and asset prices on bank profitability. Perry (1992) suggested that the effect of inflation on bank performance is dependent on whether inflation is anticipated or unanticipated. Perry (1992) pointed out that in the anticipated case, interest rates are adjusted accordingly, and this results in revenues to increase faster than costs, and subsequently positive impact on bank's profitability. On the other hand, in the unanticipated case, banks may be slow to adjust their interest rates resulting in faster increase of bank costs compared to bank revenues, and consequently negative effects on bank profitability.

Banking Sector Concentration The LN(CR3) variable (log of the three banks concentration ratio) was included to control for the impacts of competition on the efficiency of banks operating in the Bangladesh banking sector. The structure-conduct-performance (SCP) theory posits that banks in a highly concentrated market tend to collude and therefore earn monopoly profits (Molyneux *et al*., 1996), while positive impact is expected under both the collusion and efficiency views (Goddard *et al*., 2001).

H0: The relationship between banking sector concentration and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables.

H1: The relationship between banking sector concentration and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

Global Financial Crisis To control for the impacts of the global financial crisis on the efficiency of banks operating in the Bangladesh banking sector, the DUMCRIS variable (a binary dummy variable that took a value of 1 for the financial crisis years, 0 otherwise) was introduced in regression model III. It is reasonable to expect the variable to take in a negative sign since banks tend to be negatively affected by adverse economic conditions arising from slow credit growth and deteriorating credit qualities during these periods.

H0: The relationship between global financial crisis period and bank efficiency is negative after controlling for other bank specific traits and macroeconomic variables.

H1: The relationship between global financial crisis period and bank efficiency is positive after controlling for other bank specific traits and macroeconomic variables.

METHODOLOGY AND DATA

Data Envelopment Analysis (DEA)

There are two different frontier analysis methods normally employed to measure bank efficiency: the non-parametric and parametric methods (Berger & Humphrey, 1997). The most commonly employed non-parametric methods are Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH), while the parametric methods are Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA) and Distribution Free Approach (DFA). According to Murillo-Zamorano (2004), the choice of estimation approach has attracted debate since no method is strictly preferable over the other.

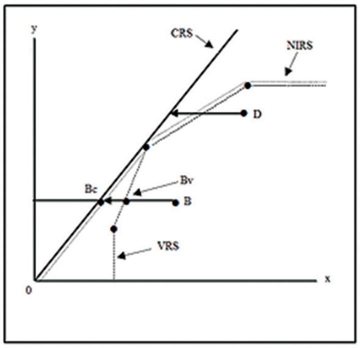
The study employs the non-parametric DEA method, also known as the mathematical programming approach to compute the efficiency of individual banks operating in the Bangladesh banking sector. The method constructs the frontier of the observed input-output ratios by linear programming techniques. The linear substitution is possible between the observed input combinations on an isoquant (the same quantity of output is produced while changing the quantities of two or more inputs) that is assumed by the DEA method.

There are six reasons why this study adopted the DEA method. First, each DMU is assigned a single efficiency score that allows ranking among the DMUs in the sample. Second, the DEA method highlights the areas of improvement for each single DMU such as either the input has been excessively used, or output has been under produced by DMU (so they could improve on their efficiency). Third, there is a possibility of making inferences on DMU's general profile. The DEA method allows for the comparison between the production performances of each DMU to a set of efficient DMUs (called reference set). Thus, the owner of DMUs may be interested to know which DMU frequently appears in this set. DMU that appears more than others in this set is called the global leader. Apparently, the DMU owner may obtain a huge benefit from this information especially in positioning its entity in the market. Fourth, the DEA method does not require a preconceived structure or specific functional form to be imposed on the data in identifying and determining the efficient frontier, error and the inefficiency structures of DMUs (e.g., Bauer *et al*., 1998; Evanoff & Israelvich, 1991; Grifell-Tatje & Lovell, 1997). Fifth, the DEA method does not need standardisation, and it therefore allows researchers to choose any kind of input and output of managerial interest (arbitrary), regardless of the different measurement units (Ariff & Can, 2008; Avkiran, 1999; Berger & Humphrey, 1997). Finally, the DEA method works fine with small sample sizes (Avkiran, 1999).

Based on the idea of Farrell (1957) who originally developed the non-parametric efficiency method, Charnes *et al*. (1978) introduced the term DEA to measure the efficiency of each DMU, obtained as a maximum of the ratio of weighted outputs to weighted inputs (hereafter referred to as the CCR model). The more the output produced from the given inputs, the more efficient is the production. The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming constant return to scale (CRS) and it delivers the overall technical efficiency (OTE). The CRS assumption is only justifiable when all DMUs are operating at an optimal scale. In practice, however, firms or DMUs may face either economies or diseconomies of scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of OTE will be contaminated with scale inefficiency (SIE).

To obtain robust results, the present study estimated efficiency under the assumption of variable returns to scale (VRS). The VRS model was first proposed by Banker *et al*. (1984), who extended the CCR model. The BCC model, which derives efficiency estimates under the VRS assumption, relaxes the CRS assumption made in the earlier study by Charnes *et al*. (1978). The VRS assumption provides the measurement of pure technical efficiency (PTE). The PTE measures the efficiency of DMUs without being contaminated by scale. Therefore, efficiency results that are derived from the VRS assumption provide more reliable information on the efficiency of DMUs (Coelli *et al*. 1998). The OTE scores obtained from CRS DEA can be divided into two components; one due to SIE and another is due to pure technical inefficiency (PTIE). If there is a difference between the two OTE scores of a DMU (CRS OTE and VRS OTE), then it indicates that DMU has SIE, and SIE could be measured from the difference between the PTE and OTE score (Coelli e*t al*., 1998).

Fig.1 provides a brief illustration. In Fig.1, under the CRS assumption, input-orientated technical inefficiency of point B is the distance BBc, meanwhile under the VRS assumption, the technical inefficiency is only BBv. Therefore, the scale inefficiency cause is due to the difference between BcBv. Although the SE measure provides information concerning the degree of inefficiency resulting from the failure of DMUs to operate with CRS, it does not provide information as to whether a DMU is operating in an area of increasing returns to scale (IRS) or decreasing returns to scale (DRS). This may be determined by running an additional DEA problem with non-increasing returns to scale (NIRS) imposed. Therefore, the nature of the scale inefficiencies, due to either IRS or DRS, could be determined by the difference between the NIRS OTE and VRS OTE scores. If VRS OTE @ PTE ≠ NIRS OTE, DMU is then said to be operating at IRS (point B). On the other hand, if VRS OTE @ PTE = NIRS OTE, DMU is then said to be operating at DRS (point D), as illustrated in Fig.1.



Source: Coelli *et al*. (1998)

Fig.1: Calculation of Scale Economies in DEA

Farrell (1957) posited that technical efficiency reflects the ability of a firm to obtain maximum output from a given set of inputs. The simplest and easiest way to measure efficiency is given as:

$$\text{Efficiency} = \frac{output}{input} \quad (1)$$

This could be done easily if a firm produces only one output by using one input. Nevertheless, firms normally produce multiple outputs by using various inputs and this method will become inadequate. Consequently, Farrell (1957) developed the measurement of relative efficiency which involves multiple, possibly incommensurate inputs and outputs. This technique aims to define a frontier of most efficient DMUs and also measure how far the frontiers are in order to determine the efficiency of DMUs. The relative efficiency could be measured as:

$$\text{Efficiency} = \frac{weighted\ sum\ of\ outputs}{weighted\ sum\ of\ inputs} \quad (2)$$

Thus, this efficiency measure could be written as:

$$\text{Efficiency of DMU } j = \frac{u_1 y_{1j} + u_2 y_{2j} + \ldots}{v_1 x_{1j} + v_2 x_{2j} + \ldots} \quad (3)$$

where

u1	is the weight given to output 1
y1j	is the amount of output 1 from DMU *j*
v1	is the weight given to input 1
x1j	is the amount of input 1 to DMU *j*

This function can be applied when a common set of weights for DMUs is applicable in comparing the efficiency between DMUs. In practice, however, to find and agree on a common set of weights that could be used is probably difficult. In fact, it is difficult to attach values to each output and input because each DMU could have its own set of criteria. The difficulty in seeking a common weight to determine the relative efficiency was recognised by Charnes *et al*. (1978). They documented the importance of different units which value inputs and outputs differently, i.e. DMUs could use different weights. Therefore, they suggested that each DMU be allowed to adopt a set of weights showing favourable light in comparison to other DMUs. Thus, in order to solve this problem, they suggested that the DEA method use DMUs that could properly value inputs or outputs differently. Hence, the DEA method allows each DMU to choose its own set of appropriate weights so that its own efficiency rating is maximised.

Thus, to maximize the efficiency of DMU j is subject to the efficiency of all DMUs being less than or equal to 1. This can be measured as:

$$\text{Maximize efficiency of DMU } j = \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \quad (4)$$

$$\text{Subject to } \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1 \text{ for each}$$

DMU j

$ur \geq \varepsilon$

$vi \geq \varepsilon$

However, the equation above represents the fractional linear of the DEA method (Bader *et al*. 2008). The linear programming could be used to solve this model by converting it to linear form. In order to achieve this, the denominator has to be set equal to constant and the numerator has to be maximized. Therefore, the resulting linear programming can be written as the maximised efficiency of DMU j

$$= \sum_{r=1}^{s} u_r y_{rj}$$

$$\text{Subject to } \sum_{i=1}^{m} v_i x_{ij} = 1$$

$$\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} \leq 1 \;\; j = 1,2,\ldots n \qquad (5)$$

$$ur \geq \varepsilon \qquad r = 1,2,\ldots s$$

$$vi \geq \varepsilon \qquad i = 1,2,\ldots m$$

where

v_i is the weight assigned to input i

x_{ij} is the level of input i used by DMU j

u_r is the weight assigned to output r

y_{rj} is the level of output r produced by DMU j

ε is a small number (of order of 10^{-6}) that ensures neither input nor output is given zero weight

In fact, if the value of efficiency of unit j is equal to 1, DMU will then be considered as efficient in the sense that no other DMU or combination of DMUs could produce more, along with at least one output dimension without worsening other output levels or utilising higher input levels. In other word, DMU is fully utilising the inputs to produce maximum outputs. However, if the value is less than 1, DMU is then considered as relatively inefficient. Hence, this model is used to find the combination of inputs and outputs weights which could maximize the efficiency of the DMU.

In order to provide a better understanding of the DEA method, a short description of the method is discussed next. Assume that the data of A as being inputs and B as being outputs for each N bank. For the *i-th* bank, these are represented by the vectors of x_i and y_i, respectively. The $A \times N$ input matrix – X, and the $B \times N$ output matrix – Y, represent the data for all N banks. To measure the efficiency of each bank, all outputs over all inputs in the form of ratios are calculated as $u'y_i / v'x_i$ where u is a $B \times 1$ vector of output weights and v is a $A \times 1$ vector of input weights. To select the optimal weight, the following mathematical programming was adopted:

$$\max_{u,v} \quad (u'y_i / v'x_i), t$$

$$\text{subject to} \quad u'y_j / v'x_j \leq 1,$$

$$u, v \geq 0.$$

$$j = 1,2,\ldots,N \quad (6)$$

However, according to Coelli *et al.* (1998), the ratio has an infinite number of solutions where, if $(u*, v*)$ is a solution, then $(\alpha u*, \alpha v*)$ is also a solution, etc. Therefore, to avoid this problem, one could impose the constraint $v'x_i = 1$, which leads to

$$\begin{aligned} &\max_{\mu,v} && (\mu' y_i), \\ &\text{subject to} && v'x_i = 1 \\ &&& \mu'y_j - v'x_j \le 0, \\ &&& \mu, v \ge 0, \\ &&& j = 1,2,...,N \end{aligned} \quad (7)$$

The changing of notation from (u,v) to (μ,v) is used to reflect transformation that is of a different linear programming problem (LP). Hence, one could derive an equivalent envelopment form using the dual form of the above problem as:

$$\begin{aligned} &\max_{\theta,\lambda} && \theta, \\ &\text{subject to} && y_i + Y\lambda \ge 0, \\ &&& \theta x_i - X\lambda \ge 0, \\ &&& \lambda \ge 0, \end{aligned} \quad (8)$$

where

- θ is a scalar representing the value of the efficiency score for the *i-th* DMU which will range between 0 and 1
- λ is a vector of constant

This envelopment form involves fewer constraints than the multiplier form $(A + B < N + 1)$, and therefore, it is generally the preferred form to solve efficiency (Coelli *et al*., 1998). For the purpose of this study, the DEA Excel Solver developed by Zhu (2009) under the VRS model was adopted to solve the profit efficiency problem. The profit efficiency model is given in equation (9). As can be seen, the profit efficiency scores are bounded within the 0 and 1 range.

Profit Efficiency

(VRS Frontier)

$$\begin{aligned} & max \sum_{r=1}^{s} q_r^o \tilde{y}_{ro} - \sum_{i=1}^{m} p_i^o \tilde{x}_{io} \\ & subject\ to \\ & \sum_{j=1}^{n} \lambda_j x_{ij} \le \tilde{x}_{io} \qquad i = 1,2,...,m; \\ & \sum_{j=1}^{n} \ddot{e}_j y_{rj} \ge \tilde{y}_{ro} \qquad r = 1,2,...,s \\ & \tilde{x}_{io} \le x_{io}, \tilde{y}_{ro} \ge y_{ro} \\ & \lambda_j \ge 0 \\ & \sum_{j=1}^{n} \lambda_{j=1} \end{aligned} \quad (9)$$

where

- s is output observation
- m is input observation
- r is s^{th} output
- i is m^{th} input
- q_r^o is unit price of the output r of DMU0 (DMU0 represents one of the n DMUs)
- p_i^o is unit price of the input i of DMU0
- $\tilde{y}_{ro}$ is r^{th} output that maximize revenue for DMU0
- $\tilde{x}_{io}$ is i^{th} input that minimize cost for DMU0
- y_{ro} is r^{th} output for DMU0
- x_{io} is i^{th} input for DMU0
- n is DMU observation

j is n^{th} DMU

λ_j is non-negative scalars

y_{rj} is s^{th} output for n^{th} DMU

x_{ij} is m^{th} input for n^{th} DMU

Panel Regression Analysis

The second objective of this study is to identify the potential bank-specific determinants and additional control variables (macroeconomic) influencing the profit efficiency of the Bangladesh banking sector. In order to examine the relationship between the efficiency of the Bangladesh banks and the contextual variables, a panel cross section regression model was employed for observation (bank) i defined as follows:

$$y_{it} = \beta\, x_{it} + \varepsilon_{it} \;\; i = 1,...,N, \qquad (1)$$

where

y_{it} is the profit efficiency of bank i at time t

x_{it} is the matrix of the contextual variables

β is the vector of coefficients

ε_{it} is a random error term representing statistical noise

i is the number of banks

t is the year

N is the number of observations in the data set

By using the profit efficiency scores as the dependent variable, this study extends equation (1) and estimates the following regression model:

$$lnPE_{jt} = \alpha_t + \beta_{jt}(lnLLRGL_{jt} + lnETA_{jt} + lnNIITA_{jt} + lnNIETA_{jt} + lnLOANSTA_{jt} + lnTA_{jt} + lnGDP_{jt} + lnINFL_{jt} + lnCR3_{jt} + DUMCRIS_{jt} + DUMSCB_{jt} + DUMPCB_{jt}) + \varepsilon_{jt}$$

where

lnPE*jt*	is the profit efficiency of the j-th bank in the period t obtained from the DEA model
lnLLRGL	is a log of loan loss reserve to gross loans
lnETA	is a log of equity to total assets
lnNIITA	is a log of non-interest income over total assets
lnNIETA	is a log of non-interest expense over total assets
lnLOANSTA	is a log of total loans over total assets
lnTA	is a log of total assets
lnGDP	is a log of gross domestic products
lnINFL	is a log of consumer price index
lnCR3	is a log of concentration ratio of the three largest banks assets
DUMCRIS	is a dummy variable for the global financial crisis years
DUMSCB	is a dummy variable of state owned commercial banks
DUMPCB	is a dummy variable of private owned commercial banks
j	is the number of banks
t	is the year
α	is a constant term
β	is the vector of coefficients
ε_{jt}	is a normally distributed disturbance term

Data Collection

The present study gathered data on all commercial banks operating in the Bangladesh banking sector during the years from 2004 to 2011. The source of financial data is the Bureau van Dijk's BankScope database, which provides banks' balance sheet and income statement information. Due to the entry and exit of banks during the years, the actual number of banks operating in the Bangladesh banking sector varies. The final sample comprised of 31 commercial banks of which complete data are available for the years 2004 to 2011. In order to maintain homogeneity, only state owned commercial banks (SCBs) and private commercial banks (PCBs) are included in the analysis. Foreign commercial banks (FCBs) and specialised development banks (SDBs) are excluded from the sample. The complete list of banks included in the study is given in Table 1 below.

TABLE 1
Commercial Banks in Bangladesh – 2004-2011

Bank	Status
Agrani Bank	SCB
Arab Bangladesh Bank Ltd. - A.B. Bank Ltd	PCB
Bangladesh Commerce Bank Ltd	PCB
Bank Asia Ltd.	PCB
BRAC Bank Ltd.	PCB
City Bank Ltd	PCB
Dhaka Bank Ltd.	PCB
Dutch-Bangla Bank Ltd.	PCB
Eastern Bank Ltd.	PCB
Export Import Bank of Bangladesh Ltd.	PCB
First Security Bank Ltd.	PCB
IFIC Bank Ltd.	PCB
Islami Bank Bangladesh Ltd.	PCB
Jamuna Bank Ltd	PCB
Janata Bank	SCB
Mercantile Bank Ltd.	PCB
Mutual Trust Bank	PCB
National Bank Ltd.	PCB
National Credit and Commerce Bank Ltd.	PCB
One Bank Ltd.	PCB
Premier Bank Ltd	PCB
Prime Bank Ltd.	PCB
Pubali Bank Ltd.	PCB
Rupali Bank Ltd.	SCB
Shahjalal Bank Ltd	PCB
Sonali Bank	SCB
Southeast Bank Ltd.	PCB
Standard Bank Ltd.	PCB
Trust Bank Ltd	PCB
United Commercial Bank Ltd	PCB
Uttara Bank Ltd.	PCB

Source: Bankscope Database
Note: SCB is State Owned Commercial Banks. PCB is Private Owned Commercial Banks

The Inputs and Outputs Variables in DEA

The definition and measurement of bank's inputs and outputs in the banking function remain arguable among researchers (Sufian, 2009; Sufian *et al.*, 2014). Thus, to determine what constitutes inputs and outputs of banks, one should first decide on the nature of banking technology (bank's approaches). According to Das and Ghosh (2006), the selection of variables in efficiency studies significantly affects the obtained results. The problem is further compounded by the fact that variables selection is often constrained by the paucity of data. Most of the financial services are jointly produced and the prices of costs and outputs are typically assigned to a bundle of financial services.

In essence, there are three main approaches that are widely used in the banking theory literature, namely, production, intermediation, and value added approaches (Sealey & Lindley, 1977). The first two approaches apply the traditional microeconomic theory of the firm to banking and differ only in the specification of banking activities. The third approach goes a step further and incorporates some specific activities of banking into the classical theory and therefore modifies it.

The first approach is the production approach which assumes that financial institutions serve as producers of services for account holders, that is, they perform transactions on deposit accounts and process documents such as loans. Previous studies, which adopted the production approach, are among others (Ferrier & Lovell, 1990; Fried *et al.*, 1993; DeYoung, 1997). The second approach, i.e. the value added approach identifies balance sheet categories (assets or liabilities) as outputs which contribute to the value added of a bank such as business associated with the consumption of real resources (Berger *et al.*, 1987). Under this approach, deposits and loans are viewed as outputs because they are responsible for the significant proportion of value added.

The third approach, the intermediation approach is the preferred approach among researchers employing the DEA method to examine the efficiency of banking sectors in developing countries (e.g., Sufian, 2011; Sufian *et al.*, 2012; Bader et al., 2008). The intermediation approach views banks as financial intermediaries. Under the intermediation approach, banks' primary role is to obtain funds from savers and convert them into loans for profit (Chu & Lim, 1998). Banks are regarded to purchase labour, materials and deposits to produce outputs such as loans and investments. Among the inputs considered include interest expense, non-interest expense, deposits, purchased capital, number of staffs (full time equivalent), physical capital (fixed assets and equipment), demographics, and competition. The potential outputs are measured as the dollar value of the bank's earning assets where the costs include both the interest and operating expenses (Berger *et al*., 1987). Some of the previous banking efficiency studies which adopted this approach are such as those by Bhattacharya *et al*. (1997), Sathye (2001), and Sufian (2009).

The present study adopts the intermediation approach attributed to three main reasons. First, the study attempts to evaluate the efficiency of the whole banking sector and not branches of a particular bank. Second, the intermediation approach is the most preferred approach among researchers investigating the efficiency of banking sectors in developing countries (e.g., Bader *et al*., 2008; Isik & Hassan, 2002 Sufian *et al*., 2013 and, Sufian & Kamarudin, 2014). Third, Sealey and Lindley (1977) suggested that financial institutions normally employ labour, physical capital, and deposits as their inputs to produce earning assets. Nevertheless, the intermediation approach is preferable in this study since it normally includes a large proportion of any bank's total costs (Elyasiani & Mehdian, 1990; Berger & Humphrey, 1991; Avkiran, 1999).

Therefore, it is reasonable to assume that the efficiency of banks in terms of their intermediation functions is crucial as an effective channel for business funding. In this vein, Jaffry *et al*. (2007) pointed out that banks play an important economic role in providing financial intermediation by converting deposits into productive investments in developing countries. The banking sector of developing countries has also been shown to perform critical role in the intermediation process by influencing the level of money stock in the economy with their ability to create deposits (Mauri, 1983; Bhatt, 1989; Askari, 1991).

For the purpose of this study, three inputs, three input prices, two outputs, and two output prices variables were chosen. The selection of the input and output variables was based on the study of Ariff and Can (2008) and other major studies on the efficiency of the banking sectors in developing countries (e.g., Sufian *et al*., 2012; Sufian, 2011; Sufian & Habibulah, 2009; Bader *et al*., 2008; Isik & Hassan, 2002). The three input vector variables consist of $x1$: Deposits, $x2$: Labour and $x3$: Capital. The input prices consist of $w1$: Price of Deposits, $w2$: Price of Labour and $w3$: Price of Capital. The two output vector variables are $y1$: Loans and $y2$: Investments. Meanwhile, the two output prices consist of $r1$: Price of Loans and $r2$: Price of Investments.

A summary of data used to construct the efficiency frontiers is presented in Table 2.

TABLE 2
Summary Statistics of the Input and Output Variables in the DEA Model

Variable	Mean	Minimum	Maximum	Std. Deviation
Deposit (*x1*)	80,473.73	4,305.00	535,288.40	85,440.89
Labour (*x2*)	1,213.56	51.10	9,345.60	1,402.48
Capital (*x3*)	1,808.54	17.30	23,026.40	2,754.99
Loan (*y1*)	65,040.53	3,073.00	345,991.30	64,038.10
Investment (*y2*)	13,959.01	200.00	134,075.80	20,521.95
Price of deposit (*w1*)	0.07	0.03	0.17	0.02
Price of labour (*w2*)	0.01	0.01	0.02	0.00
Price of capital (*w3*)	1.19	0.08	18.98	1.79
Price of loan (*r1*)	0.12	0.05	0.25	0.03
Price of investment (*r2*)	0.12	0.00	0.81	0.12

Notes: x1: Deposits (deposits and short term funding), x2: Labour (personnel expenses), x3: Capital (fixed assets), y1: Loans (gross loan), y2: Investment (total security), w1: Price of deposits (total interest expenses/ deposits), w2: Price of labour (personnel expenses/ total assets), w3: Price of capital (other operating expenses/ capital), r1: Price of loans (interest income from loans / loans), r2: Price of investment (other operating income/ investment)

Variables Used in Panel Regression Analysis

Six bank specific variables were included in the regression models. The ratio of loan loss reserves to gross loans (LLR/GL) was incorporated as an independent variable in the regression analysis as a proxy of credit risk. Meanwhile, the ratio of equity to total assets (E/TA) was also included in the regression models to examine the relationship between efficiency and bank capitalisation. To recognise that banks have increasingly been generating income from "off-balance sheet" businesses in recent years, the ratio of non-interest income over total assets (NII/TA) was entered in the regression analysis as a proxy measure of bank diversification into non-traditional activities. The ratio of non-interest expenses to total assets (NIE/TA) was used to provide information on the variations of bank operating costs. The LOANS/TA variable was included in the regression models as a proxy measure of bank's loans intensity. The TA variable is included in the regression models as a proxy of size to capture the possible cost advantages associated with size (economies of scale). This variable controls for cost differences according to the size of the bank.

The performance of banks tends to be sensitive to macroeconomic and market conditions. To address this concern, gross domestic products (GDP) were used to control for cyclical output effects. In addition, macroeconomic risk was also taken into account by controlling for the rate of inflation (INFL). CR3 (measured as the concentration ratio of the three largest banks in terms of assets) was entered into the regression models as a proxy variable for the banking sector's concentration.

The DUMCRIS variable (a binary dummy variable that takes a value of 1 for the global financial crisis period, 0 otherwise) was included in regression model III to examine the impacts of the global financial crisis on the efficiency of banks operating in the Bangladesh banking sector.

To capture the effects of organisational forms on bank efficiency, similar regression models were performed by including DUMSCB (a binary variable that takes a value of 1 for the state owned commercial bank, 0 otherwise) and DUMPCB (a binary variable that takes a value of 1 for the private commercial bank, 0 otherwise) in regression models IV and V, respectively.

A summary of the statistics of the dependent and independent variables is given in Table 3.

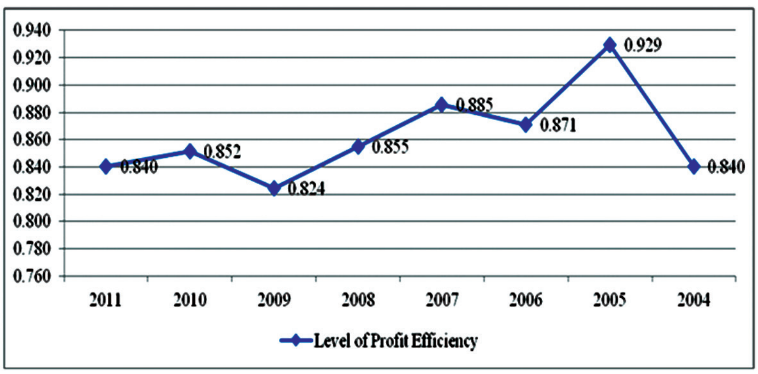
TABLE 3
Descriptive of the Variables Used in the Panel Regression Analysis

Variable	**Description**	**Mean**	**Std. Dev.**	**Sources/ Database**
	Dependent			
LN(PE)	Natural log of the profit efficiency derived from the DEA method.	-0.079	0.107	Authors' own calculation
	Independent			
	Bank Specific Factors			
LN(LLR/GL)	Natural log of loan loss reserves/gross loans. An indicator of credit risk, which shows how much a bank is provisioning in year t relative to its total loans.	0.379	0.307	Banks' annual financial statements
LN(ETA)	A measure of bank's capital strength in year *t*, calculated as the natural log of equity/ total assets.	0.826	0.240	Banks' annual financial statements
LN(NII/TA)	A measure of bank's diversification towards non-interest income, computed as the natural log of non-interest income over total assets.	0.452	0.192	Banks' annual financial statements
LN(NIE/TA)	Calculated as the natural log of non-interest expense/ total assets and provides information on the efficiency of the management regarding expenses relative to assets in year *t*.	0.484	0161	Banks' annual financial statements
LN(LOANS/TA)	A measure of bank's loans intensity calculated as the natural log of total loans divided by total assets.	1.824	0.058	Banks' annual financial statements
LN(TA)	The natural log of the accounting value of bank *j's* total assets in year *t*.	4.836	0.384	Banks' annual financial statements
	Macroeconomic and Markets Conditions			
LN(GDP)	The natural log of gross domestic products.	3.514	0.056	IMF International Financial Statistics.
LN(INFL)	The natural log of the rate of inflation.	0.898	0.095	IMF International Financial Statistics.
LN(CR3)	The natural log of the three largest banks asset concentration ratio.	1.607	0.071	IMF International Financial Statistics.
DUMCRIS	A binary variable that takes a value of 1 for the global financial crisis period, 0 otherwise.	N.A.	N.A.	Authors' Own Calculations
				Ownership
DUMSCB	A binary variable that takes a value of 1 for the state-owned commercial bank, 0 otherwise.	N.A.	N.A.	Authors' Own Calculations
DUMPCB	A binary variable that takes a value of 1 for the private commercial bank, 0 otherwise.	N.A.	N.A.	Authors' Own Calculations

EMPIRICAL RESULTS

Profit Efficiency of the Bangladesh Banking Sector: Evidence from Specific Years

Table 4 shows the mean level of profit efficiency for the Bangladesh banking sector for specific years from 2004 to 2011. The results seem to suggest in 2004, the profit efficiency was the highest at 92.9%, while the lowest was during 2009 at 82.4% (see Fig.2). In other words, the Bangladesh banking sector is said to have slacked if they fail to fully minimise costs and maximise revenues resulting in the existence of profit inefficiency. The empirical findings seem to indicate that the highest (lowest) level of profit efficiency (inefficiency) was attained in 2004 [84.0% (7.1%)], while the lowest (highest) level of profit efficiency (inefficiency) was recorded during 2009 [82.4% (17.6%)]. In essence, the empirical findings from this study indicate that on average, Bangladesh banks earned 92.9% in the year 2004, but only 82.4% during 2009 and lost the opportunity to make 7.1% and 17.6% more profit from the same level of inputs in 2004 and 2009.



Source: Authors' Own Calculations

Fig.2. Level of Profit Efficiency in the Bangladesh Commercial Banking Sector by Year

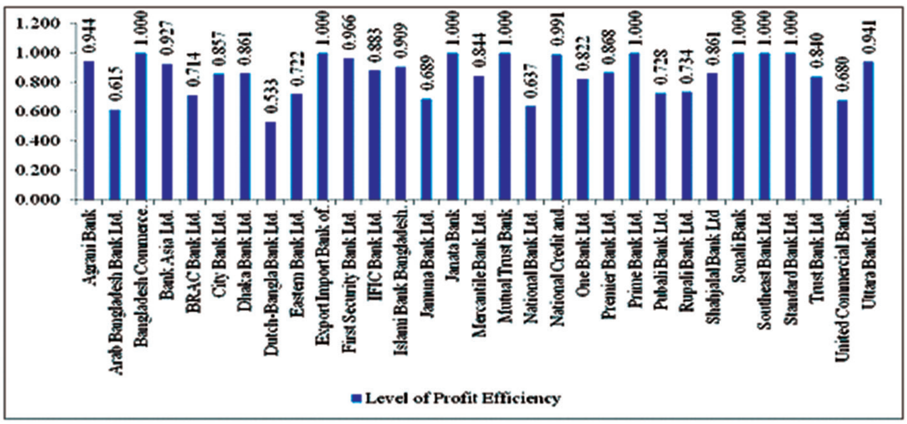
Profit Efficiency of the Bangladesh Banking Sector: Evidence from Specific Banks

The mean profit efficiency levels for specific banks during the years 2004 to 2011 are given in Table 4. The empirical findings seem to suggest that eight banks (Bangladesh Commerce Bank, Export Import Bank of Bangladesh, Janata Bank, Mutual Trust Bank, Prime Bank, Sonali Bank, Southeast Bank, and Standard Bank) exhibited the maximum profit efficiency level. This proves that these banks have not slacked in their intermediation function and have been successful to fully maximise revenues while minimising costs and subsequently attaining perfect profit efficiency.

TABLE 4
Summary on the Level of Profit Efficiency

Bank	2011	2010	2409	2008	2007	2006	2005	2004	Mean Bank
Agrani Bank	1.000	0.782	0.770	1.000	1.000	1.000	1.000	1.000	**0.944**
Arab Bangladesh Bank	0.612	0.625	0.667	0.556	–	–	–	–	**0.615**
Bangladesh Commerce Bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	**1.000**
Bank Asia	0.713	0.706	1.000	1.000	1.000	1.000	1.000	1.000	**0.927**
BRAC Bank	0.560	1.000	0.580	–	–	–	–	–	**0.714**
City Bank	1.000	0.714	–	–	–	–	–	–	**0.857**
Dhaka Bank	0.756	0.742	0.910	1.000	1.000	0.912	1.000	0.568	**0.861**
Dutch-Bangla Bank	0.551	0.639	0.483	0.487	0.463	0.568	0.630	0.446	**0.533**
Eastern Bank	0.704	0.739	–	–	–	–	–	–	**0.722**
Export Import Bank of Bangladesh	1.000	1.000	1.000	1.000	–	–	–	–	**1.000**
First Security Bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.725	**0.966**
IFIC Bank	0.989	0.781	0.620	1.000	1.000	0.674	1.000	1.000	**0.883**
Islami Bank Bangladesh	1.000	1.000	1.000	1.000	1.000	0.271	1.000	1.000	**0.909**
Jamuna Bank	0.456	0.645	0.747	0.588	1.000	0.824	0.913	0.342	**0.689**
Janata Bank	1.000	1.000	1.000	–	–	–	–	–	**1.000**
Mercantile Bank	0.663	0.757	0.700	0.858	0.815	1.000	0.963	1.000	**0.844**
Mutual Trust Bank	1.000	1.000	1.000	–	–	–	–	–	**1.000**
National Bank	1.000	1.000	0.613	0.656	0.344	0.532	0.445	0.506	**0.637**
National Credit and Commerce Bank	1.000	1.000	1.000	1.000	1.000	0.931	1.000	1.000	**0.991**
One Bank	0.731	0.780	0.734	0.670	0.701	0.962	1.000	1.000	**0.822**
Premier Bank	0.733	1.000	0.870	–	–	–	–	–	**0.868**
Prime Bank	1.000	1.000	1.000	1.000	1.000	1.000	–	–	**1.000**
Pubali Bank	0.809	0.809	0.876	0.852	0.697	0.614	0.639	0.529	**0.728**
Rupali Bank	0.474	0.554	0.620	0.534	1.000	1.000	1.000	0.688	**0.734**
Shahjalal Bank	0.754	0.513	0.622	1.000	1.000	1.000	1.000	1.000	**0.861**
Sonali Bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	**1.000**
Southeast Bank	1.000	1.000	1.000	–	–	–	–	–	**1.000**
Standard Bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	**1.000**
Trust Bank	1.000	1.000	0.437	0.705	0.575	1.000	1.000	1.000	**0.840**
United Commercial Bank	0.774	0.615	0.650	–	–	–	–	–	**0.680**
Uttara Bank	0.765	1.000	1.000	0.761	1.000	1.000	1.000	1.000	**0.941**
Mean Year	**0.840**	**0.852**	**0.824**	**0.855**	**0.885**	**0.871**	**0.929**	**0.840**	**0.857**

Fig.3 illustrates that United Commercial Bank 68% (32%), National Bank 63.7% (36.3%), Arab Bangladesh Bank 61.5% (38.5%) and Dutch-Bangla Bank 53.3% (46.7%) exhibited the lowest (highest) profit efficiency (profit inefficiency). The results indicate that these four banks earned the lowest of what was available and therefore greater loss of opportunity to make higher profits despite the fact that they were utilising the same level of inputs compared to their peers.



Source: Authors' Own Calculations

Fig.3: Level of Profit Efficiency in the Bangladesh Commercial Banking Sector: By Banks

Determinants of Profit Efficiency

In essence, the results from the first stage identify the levels of profit efficiency of the Bangladesh banking sector for the specific years and banks. In what follows, we proceeded to identify the determinants that could improve the profit efficiency in the Bangladesh banking sector. To do so, the five panel regression models presented in columns I to V of Table 5 were estimated. For Model I, which is the baseline regression model, all six bank specific variables namely LN(LLR/GL), LN(E/TA), LN(NII/TA), LN(NIE/TA), LN(LOANS/TA) and LN(TA) were included. In regression model II, the macro and market conditions variables, namely LN(GDP), LN(INFL) and LN(CR3) were introduced, while the bank specific variables were retained in the regression model. In regression model III, the DUMCRIS variable was included to control for the global financial crisis period. The DUMSCB and DUMPCB were introduced in regression models IV and V respectively to examine the impacts of ownership on the profit efficiency of banks in Bangladesh.

TABLE 5
Second Stage Panel Regression Analysis

Explanatory Variables	Model (I)	Model (II)	Model (III)	Model (IV)	Model (V)
CONSTANT	-0.807***	0.291	0.174	0.066	0.148
	(0.421)	(1.207)	(1.305)	(1.257)	(1.194)
Bank Specific Characteristics					
LN(LLR/GL)	0.057**	0.062**	0.062**	0.057**	0.057**
	(0.026)	(0.029)	(0.028)	(0.031)	(0.030)
LN(E/TA)	-0.010	0.032	0.031	0.050	0.050
	(0.036)	(0.059)	(0.060)	(0.066)	(0.064)
LN(NII/TA)	-0.087***	-0.091***	-0.091***	-0.074***	-0.074***
	(0.032)	(0.030)	(0.032)	(0.039)	(0.038)
LN(NIE/TA)	-0.046	-0.047	-0.046	-0.042	-0.042
	(0.066)	(0.071)	(0.070)	(0.072)	(0.069)
LN(LOANS/TA)	0.488**	0.555**	0.556**	0.675**	0.674**
	(0.189)	(0.220)	(0.226)	(0.268)	(0.259)
LN(TA)	-0.023**	0.021	0.020	-0.017	-0.017
	(0.012)	(0.040)	(0.041)	(0.051)	(0.050)
Macroeconomic and Market Conditions					
LN(GDP)	–	-0.414	-0.394	-0.351	-0.351
		(0.376)	(0.403)	(0.388)	(0.376)
LN(INFL)	–	0.054	0.064	0.052	0.052
		(0.032)	(0.064)	(0.028)	(0.027)
LN(CR3)	–	-0.039	-0.013	-0.077	-0.077
		(0.141)	(0.217)	(0.135)	(0.131)
DUMCRIS	–	–	-0.004	–	–
			(0.023)		
Ownership					
DUMSCB	–	–	–	0.082	–
				(0.059)	
DUMPCB	–	–	–	–	-0.082
					(0.057)
No. of Obs.					
R^2	0.074	0.089	0.088	0.100	0.100
Adj. R^2	0.039	0.037	0.030	0.043	0.043
Durbin Watson	1.324	1.324	1.330	1.331	1.331
F-statistic	2.144	1.707	1.524	1.742	1.742
Hausman test χ^2	11.056*	11.437	11.015	7.722	7.722

Note: The dependent variable is the profit efficiency derived from the DEA method. LN(LLR/GL) is a measure of bank's credit risk, calculated as the log of loan loss reserves divided by total loans. LN(E/TA) is a measure of banks capitalization measured by banks total shareholders equity divided by total assets. LN(NII/TA) is a measure of bank's diversification towards non-interest income, calculated as log of total non-interest income divided by total assets. LN(NIE/TA) is a measure of bank management quality calculated as log of total non-interest expenses divided by total assets. LN(LOANS/TA) is a measure of bank's loans intensity calculated as the log of total loans to bank total assets. LN(TA) is the size of the bank's total asset measured as log of total bank assets. LN(GDP) is the log gross domestic product. LN(INFL) is the log of rate of inflation. LN(CR3) is the log of the three largest banks asset concentration ratio. DUMCRIS is a binary variable that takes a value of 1 for the global financial crisis period, 0 otherwise. DUMSCB is a binary variable that takes a value of 1 for the state-owned commercial bank, 0 otherwise. DUMPCB is a binary variable that takes a value of 1 for the private commercial bank, 0 otherwise.

Values in parentheses are standard errors.
***, **, and * indicates significance at 1, 5 and 10% levels.

Table 5 presents results from the panel regression analysis. Before proceeding with the regression results, the Hausman test was employed to choose between the Random Effects Model (REM) and Fixed Effects Model (FEM). The results from the Hausman test given at the bottom of Table 5 clearly indicate that REM is preferable compared to FEM for the analysis (as observed, the null hypothesis failed to be rejected at the 1% or 5% significance levels). Therefore, for the purpose of this study, the work was proceeded with the analysis based on REM.

Concerning the impact of credit risk, it is interesting to find that the coefficient of LN(LLR/GL) has consistently exhibited a positive sign (statistically significant at the 5% level in all regression models), suggesting that banks with higher credit risk tend to report higher profit efficiency. The result is in consonance with the *skimping* hypothesis. To recap, Berger and DeYoung (1997) suggested that under the *skimping* hypothesis, a bank maximising the long-run profits might rationally choose to have lower costs in the short run by skimping on the resources devoted to loans monitoring, but bear the consequences of greater loan performance problems.

The coefficient of NII/TA has consistently exhibited a negative sign (statistically significant in all regression models at the 1% level). The results imply that banks which derived a higher proportion of its income from non-interest sources such as fee based services tend to be relatively less efficient in their intermediation function. The finding is in consonance with the earlier studies by among others Stiroh (2006a), Stiroh (2006b), and Stiroh and Rumble (2006). To recap, Stiroh and Rumble (2006) found that diversification benefits of the U.S. financial holding companies are offset by the increased exposure to non-interest activities, which are much more volatile, but not necessarily more profitable than interest generating activities.

Referring to the impacts of bank's loan intensity, it was found that LN(LOANS/TA) is positively related to the profit efficiency of banks operating in the Bangladesh banking sector. The liquidity risk arises from the possible inability of banks to accommodate declining liabilities or to provide funds on the assets' side of the balance sheet. This is considered an important determinant of the banks' efficiency. Higher expected return is expected to be generated from the risky loan market (bank's asset). Thus, a higher liquidity is required to fund large loans in order to increase the profitability of the banks and this implies that liquidity has a positive relationship with banks' profit efficiency (Sufian, 2009). Within the context of the Bangladesh banking sector, the findings imply that banks with higher loans-to-asset ratios tend to be relatively more efficient in their intermediation activities. Thus, bank loans seem to be more highly valued than alternative bank outputs such as investments and securities.

It was also found that the coefficient of the DUMCRIS variable entered the regression model with a negative sign, but is not statistically significant at any conventional levels. To some extent, the results provide support to the arguments that the impact of the global financial crisis has no significant influence on the profit efficiency of banks operating in the Bangladesh banking sector. Unlike the banking sectors in the western and developed countries which are more developed and are widely involved in financial engineering techniques and products, banks operating in the Bangladesh banking sector focus more on agricultural based financing activities and products.

The empirical findings given in column IV of Table 5 seem to suggest that the coefficient of DUMSCB exhibits a positive sign. To some extend, the empirical findings suggest that the state owned commercial banks tend to be relatively more profit efficient compared to their private and foreign owned commercial bank counterparts. However, the results need to be interpreted with caution since the coefficient of the variable is not statistically significant at any conventional levels. Similarly, it can be observed from column V of Table 5 that the coefficient of DUMPCB entered the regression model with a negative sign, but not statistically significant at any conventional levels.

CONCLUSION

To date, studies on bank efficiency are numerous. However, most of these studies have concentrated on the banking sectors of the western and developed countries. On the other hand, empirical evidence on the developing countries is relatively scarce and the majority of these studies focus on the technical, pure technical, and scale efficiency concepts. The present study attempts to fill in this demanding gap and provides new empirical evidence on the profit efficiency of the Bangladesh banking sector during the period of 2004 to 2011. The present study consists of two stages. In the first stage, the non-parametric Data Envelopment Analysis (DEA) method was employed to measure the level of profit efficiency of individual banks operating in the Bangladesh banking sector. In the second stage, panel regression analysis was used to examine the determinants of the profit efficiency of Bangladesh banks.

The empirical findings from the first stage indicate that the Bangladesh banking sector exhibited the highest profit efficiency level in 2004, while profit efficiency seemed to be at the lowest level during 2009. It was found that Bangladesh Commerce Bank, Export Import Bank of Bangladesh, Janata Bank, Mutual Trust Bank, Prime Bank, Sonali Bank, Southeast Bank, and Standard Bank have exhibited a perfect or 100% profit efficiency level. On the other hand, United Commercial Bank, National Bank, Arab Bangladesh Bank, and Dutch-Bangla Bank were shown to be the least profit efficient banks during the period under study.

The results from the panel regression analysis indicate that banks with higher credit risk tend to report higher profit efficiency, which is in line with the *skimping* hypothesis. Similarly, a negative relationship was found between bank profit efficiency and the level of liquid assets held by the bank, implying that banks with higher loans-to-asset ratios tend to be relatively more efficient in their intermediation function. The empirical findings seem to suggest that banks which derived a higher proportion of its income from non-interest sources such as fee based services tend to be relatively less efficient in their intermediation function. It could be argued that non-interest activities may expose banks to excessive volatility, but may not necessarily be more profitable compared to interest generating activities.

The empirical findings from this study clearly call for regulators and decision makers to review the profit efficiency of banks operating in the Bangladesh banking sector. This consideration is vital because profit efficiency is the most important concept which could lead to higher or lower profitability of the banking sector. Hence, to improve the performance of banks, regulators may need to employ and exercise the same information technologies, skills, and risk management techniques which are applied by the most efficient banks.

The results could also provide better information and guidance to bank managers, as banks need to have clear understanding of the impact of profit efficiency on the performance of the banks. Thus, banks operating in the Bangladesh banking sector have to consider all the potential technologies which could improve their profit efficiency levels since the main motive of banks is to maximise shareholders' value or wealth through profit maximization.

Furthermore, the results from this study may have implications for investors whose main desire is to reap higher profit from their investments. By doing so, they could concentrate mostly on the potential profitability of the banks before investing. Therefore, the findings of this study may help investors plan and strategise on the performance of their investment portfolios. Thus, it is reasonable to suggest that wise decisions investors make today will significantly influence the level of expected returns in the future.

Finally, the findings of this study are expected to contribute significantly to the existing knowledge on the operating performance of the Bangladesh banking sector. Nevertheless, the study has also provided insights into the bank's specific management, as well as policymakers with regard to attaining optimal utilization of capacities, improvement in managerial expertise, efficient allocation of scarce resources, and the most productive scale of operation of commercial banks operating in the Bangladesh banking sector. This may also facilitate directions for sustainable competitiveness of the Bangladesh banking sector operations in the future.

Due to its limitations, the paper could be extended in a variety of ways. Firstly, future research could include more variables such as taxation and regulation indicators, exchange rates, as well as indicators of the quality of the offered services. Secondly, in terms of methodology, the non-parametric Malmquist Productivity Index (MPI) method could be employed to investigate changes in productivity over time as a result of technical change or technological progress or regress could yet be another extension to the present paper. Finally, future research into the efficiency of the Bangladesh banking sector could also consider the production function along with the intermediation function.

REFERENCES

Adongo, J., Strok, C., & Hasheela, E. (2005). Measuring the Alternative Profit X-efficiency of Namibia's Banking Sector. *Nepru Research Report, 36*, 1-58.

Akhavein, J. D., Berger, A. N., & Humphrey D. B. (1997). The Effects of Megamergers on Efficiency and Prices: Evidence from a Bank Profit Function. *Review of Industrial Organization, 12*(1), 95-139.

Akhigbe, A., & McNulty, J. E. (2003). The Profit Efficiency of Small US Commercial Banks. *Journal of Banking and Finance, 27*(2), 307-325.

Ariff, M., & Can, L. (2008). Cost and Profit Efficiency of Chinese Banks: A Non-Parametric Analysis. *China Economic Review, 19*, 260-273.

Askari, H. (1991). Third World Debt and Financial Innovation: The Experiences of Chile and Mexico. *OECD Development Studies*, Paris: OECD.

Avkiran, N. K. (1999). The Evidence on Efficiency Gains: The Role of Mergers and the Benefits to the Public. *Journal of Banking and Finance, 23*(7), 991-1013.

Bader, K. M. I., Mohammed, S., Ariff, M., & Hassan, T. (2008). Cost, Revenue and Profit Efficiency of Islamic Versus Conventional Banks: International Evidence Using Data Envelopment Analysis. *Islamic Economic Studies, 15*, 24-76.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science, 30*, 1078-1092.

Bauer, P. W., Berger, A. N., Ferrier, G. D., & Humphrey, D. B. (1998). Consistency Conditions for Regulatory Analysis of Financial Institutions: A Comparison of Frontier Efficiency Methods. *Journal of Economics and Business, 50*(2), 85-114.

Berger, A. N., & Humphrey, D. B. (1991). The Dominance of Inefficiencies Over Scale and Product Mix Economies in Banking. *Journal of Monetary Economics, 28*, 117-148.

Berger, A. N., & DeYoung, R. (1997). Problem Loans and Cost Efficiency in Commercial Banks. *Journal of Banking and Finance, 21*(6), 849–870.

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of Financial Institutions: International Survey and Directions for Future Research. *European Journal of Operations Research, 98*, 175-212.

Berger, A. N., & Mester, L. J. (2003). Explaining the Dramatic Changes in Performance of US Banks: Technological Change, Deregulation, and Dynamic Changes in Competition. *Journal of Financial Intermediation, 12*, 57–95.

Berger, A. N., Hanweck, G. A., & Humphrey, D. B. (1987). Competitive Viability in Banking: Scale, Scope and Product Mix Economies. *Journal of Monetary Economics, 20*(3), 501–520.

Bhattacharyya, A., Lovell, K. C. A., & Sahay, P. (1997). The Impact of Liberalization on the Productive Efficiency of Indian Commercial Banks. European Journal of Operational Research, 98, 332-345.

Bhatt, V. V. (1989). *Financial Innovation and Credit Market Development*. Working Paper: World Bank.

Button, K. J., & Jones, W. T. G. (1992). Ownership Structure, Institutional Organization and Measured X-Efficiency. *American Economic Review, 82*(2), 439-445.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. European *Journal of Operational Research, 2*, 429-444.

Chu, S. F., & Lim, G. H. (1998). Share Performance and Profit Efficiency of Banks in an Oligopolistic Market: Evidence from Singapore. *Journal of Multinational Financial Management, 8*(2-3), 155-168.

Coelli, T., Prasada-Rao, D. S., & Battese, G. E. (1998). *An Introduction to Efficiency and Productivity Analysis*. Kluwer Academic Publishers, Boston.

Das, A., & Ghosh, S. (2006). Financial Deregulation and Efficiency: An Empirical Analysis of Indian Banks During the Post Reform Period. *Review of Financial Economics, 15*(3), 193-221.

DeYoung, R. (1997). Bank Mergers, X-Efficiency and the Market for Corporate Control. *Managerial Finance, 23*(1), 32-47.

Elyasiani, E., & Mehdian, S. (1990). Efficiency in the Commercial Banking Industry: A Production Frontier Approach. *Applied Economics 22*(4), 539-551.

Evanoff, D. D., & Israelvich, P. R. (1991). Productive Efficiency in Banking. *Economic Perspectives, Federal Reserve Bank of Chicago*, 11-32.

Fare, R., Grosskopf, S., & Lovell, K. C .A. (1985). *The Measurement of Efficiency of Production*. Kluwer-Nijhoff Publishers: Boston.

Fare, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity Growth, Technical Progress and Efficiency Change in Industrialized Countries. *The American Economic Review, 84*(1), 66-83.

Farrell, M. J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society, 120*(3), 253-290.

Ferrier, G. D. & Lovell, K. C. A. (1990). Measuring Cost Efficiency in Banking: Econometric and Linear Programming Evidence. *Journal of Econometrics, 46*(1-2), 229-245.

Fried, H. O., Lovell, K. C. A., & Eeckaut, P. V. (1993). Evaluating the Performance of U.S. Credit Unions. *Journal of Banking and Finance, 17*(2-3), 251-265.

Goddard, J., Molyneux, P., & Wilson, J. O. S. (2001). *European Banking: Efficiency, Technology and Growth*. New York, NY: John Wiley and Sons.

Grifell-Tatje, E. & Lovell, K. C. A. (1997). The Sources of Productivity Change in Spanish Banking. *European Journal of Operational Research, 98*(2), 364-380.

Isik, I., & Hassan, K. M. (2002). Cost and Profit Efficiency of the Turkish Banking Industry: *An Empirical Investigation. The Financial Review, 37*(2), 257-280.

Jaffry, S., Ghulam, Y., Pascoe, S., & Cox, J. (2007). Regulatory Changes and Productivity of the Banking Sector in the Indian Sub-Continent. *Journal of Asian Economics, 18*, 415-438.

Kamarudin, F., Nordin, B. A. A., & Nasir, A. M. (2013). Price efficiency and returns to scale of banking sector in gulf cooperative council countries: Empirical evidence from Islamic and conventional banks. *Economic Computation and Economic Cybernetics Studies and Research, 47*, 215-236.

Kamarudin, F., Nordin, B. A. A., Muhammad, J., & Hamid, M. A. A. (2014a). Cost, revenue and profit efficiency of Islamic and conventional banking sector: Empirical evidence from Gulf Cooperative Council countries. *Global Business Review, 15*, 1-24.

Kamarudin, F., Nasir, A. M., Yahya, M. H., Said, R. M., & Nordin, B. A. A. (2014b). Islamic banking sectors in Gulf Cooperative Council countries. Analysis on revenue, cost and profit efficiency concepts. *Journal of Economic Cooperation and Development, 35*, 1-42.

Koopmans, T. C. (1951). An Analysis of Production As An Efficient Combination of Activities. In T. C. Koopmans (Ed.), *Activity Analysis of Production and Allocation* (pp. 33-97). New York, NY: John Wiley and Sons.

Laeven, L., & Majnoni, G. (2003). Loan Loss Provisioning and Economic Slowdowns: Too Much, Too Late? *Journal of Financial Intermediation, 12*(2), 178-197.

Levine, R. (1998). The Legal Environment, Banks, and Long-Run Economic Growth. *Journal of Money, Credit and Banking, 30*(3), 596-613.

Liebstein, H. (1966). Alocative Efficiency vs. X-Efficiency. *American Economic Review, 56*(3), 392-415.

Maudos, J., & Pastor, J. M. (2003). Cost and Profit Efficiency in the Spanish Banking Sector (1985–1996): A Non-Parametric Approach. *Applied Financial Economics, 13*(1), 1-12.

Maudos, J., Pastor, J. M., Francisco, P. G., & Javier, Q. I. (2002). Cost and Profit Efficiency in European Banks. *Journal of International Financial Markets, Institutions and Money, 12*(1), 33-58.

Mauri, A. (1983). The Potential for Savings and Financial Innovation in Africa. *Savings and Development, 7*, 319-337.

Micco, A., Panizza, U., & Yanez, M. (2007). Bank Ownership and Performance: Does Politics Matter? *Journal of Banking and Finance, 31*(1), 219-241.

Miller, S. M., & Noulas, A. G. (1997). Portfolio Mix and Large Bank Profitability in the USA. *Applied Economics 29*(4), 505-512.

Molyneux, P., Altunbas, Y., & Gardener, E. P. M. (1996). *Efficiency in European Banking*. Chichester: John Wiley & Sons.

Murillo-Zamorano, L. R. (2004). Economic Efficiency and Frontier Techniques. *Journal of Economic Surveys, 18*(1), 33−77.

Perry, P. (1992). Do Banks Gain or Lose from Inflation. *Journal of Retail Banking, 14*(2), 25-40.

Sathye, M. (2001). X-Efficiency in Australian Banking: An Empirical Investigation. *Journal of Banking and Finance, 25*(3), 613-30.

Schumpeter, J. A. (1934). *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.

Sealey, C. W., & Lindley, J. T. (1977). Inputs, Outputs and a Theory of Production and Cost at Depository Financial Institutions. *Journal of Finance, 32*(4), 1251-1266.

Shameem, A. K. M. (1995). Impact of Flexible Interest Rate on Savings and Investment. *Bangladesh Journal of Political Economy, 13*(2), 62-78.

Staikouras, C., & Wood, G. (2004). The Determinants of European Bank Profitability. *International Business and Economics Research Journal, 3*(6), 57-68.

Stiroh, K. J. (2006a). New Evidence on the Determinants of Bank Risk. *Journal of Financial Services Research, 30*(3), 237-263.

Stiroh, K. J. (2006b). A Portfolio View of Banking with Interest and Non-Interest Activities. *Journal of Money, Credit and Banking, 38*(5): 1351-1361.

Stiroh, K. J., & Rumble, A. (2006). The Dark Side of Diversification: The Case of US Financial Holding Companies. *Journal of Banking and Finance, 30*(8), 2131-2161.

Sufian, F. (2009). Determinants of Bank Efficiency During Unstable Macroeconomic Environment: Empirical Evidence from Malaysia. *Research in International Business and Finance, 23*(1), 54-77.

Sufian, F. (2011). Benchmarking the efficiency of the Korean banking sector: a DEA approach. *Benchmarking: An International Journal, 18*(1), 107-127.

Sufian, F. & Habibullah, M. S. (2009). Asian Financial Crisis and the Evolution of Korean Banks Efficiency: A DEA Approach. *Global Economic Review, 38*(4), 335-369.

Sufian, F., Kamarudin, F., & Noor, N. H. H. M. (2012). Determinants of Revenue Efficiency in the Malaysian Islamic Banking Sector. *Journal of King Abdulaziz: Islamic Economics, 25*(2), 195-224.

Sufian, F., Kamarudin, F., & Noor, N. H. H. M. (2013). Assessing the revenue efficiency of domestic and foreign Islamic banks: Empirical evidence from Malaysia. *Jurnal Pengurusan, 37*, 77-90.

Sufian, F. & Kamarudin, F. (2014). Efficiency and returns to scale in the Bangladesh banking sector: empirical evidence from the slack-based DEA method. *Inzinerine Ekonomika - Engineering Economics, 25*(5), 549-557

Sufian, F., Kamarudin, F., & Noor, N. H. H. M. (2013). Revenue efficiency and returns to scale in Islamic banks: Empirical evidence from Malaysia. *Journal of Economic Cooperation and Development, 35*(1), 47-80

Sufian, F., Muhammad, J., Nordin, B. A. A., Yahya, M. H. & Kamarudin, F. (2013). Assessing the effect of mergers and acquisition on revenue efficiency: Empirical Evidence from Malaysian banking sector. *International Journal of Economic Research, 10(*2), 297-313

Zhu, J. (2009). *Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets and DEA Excel Solver*. International Series in Operations Research and Management Science: New York, NY: Springer.