



A proposed Islamic banking efficiency framework: A Fuzzy Data Envelopment Analysis (FDEA) investigation

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ABSTRACT

This study proposes a framework that focuses on Islamic banking efficiency with an application of Fuzzy Data Envelopment Analysis (FDEA), which is part of an on-going doctoral research programme associated with the determination of the efficiency of Islamic banking. This study will hopefully will assist researchers in studying the efficiency of Islamic banking to make the appropriate selection of inputs and outputs.

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Keywords

Efficiency,
Islamic Banking,
Data Envelopment Analysis (DEA),
Fuzzy Data Envelopment Analysis (FDEA).

Introduction

Efficiency measurement is one aspect of a firm's performance. Efficiency can be measured with respect to maximization of output, minimization of cost or maximization of profits. According to Ahmad Mokhtar et al. (2006), generally, the efficiency analysis of a production or service unit refers to the comparison between the outputs and inputs used in the process of producing a product or services.

The concept of efficiency was first discussed by Farrell (1957). Empirically, Farrell (1957) has measures the efficiency through two different components, which are technical efficiency (TE) and allocative efficiency (AE). According to him, technical efficiency can be defined as the firm's ability to obtain as large as possible an output from a combination of inputs, while the allocative efficiency refer to the firm's ability to use inputs in optimal proportions, given their respective prices and production technology.

In banks efficiency arena, banks has produced more outputs from a given set of input or use less input to produce a given level of output (Kumbhakar and Lovell, 2003). According to literatures (eg: Kamaruddin et al., 2008; Mokhtar et al., 2008; Yudistira, 2003; Ibrahim and Abdelgadir et al. (n.d.); Majid et al., 2009; Moussawi and Obeid, 2010; Sufian, 2007)). Most of these papers are using non-parametric approach of Data Envelopment Analysis (DEA) and Stochastic Frontier Approach (SFA) as a method to assess either the efficiency of Islamic or Conventional banks. Berger and Mester (1997) repoted that, the most common efficiency estimation techniques are data envelopment analysis (DEA), free disposable hull analysis (FDH), the stochastic frontier approach (SFA), the thick frontier approach (TFA), and the distribution-free approach (DFA). However, Wu et al. (2006) have applied and compared fuzzy

DEA with the results from traditional DEA analysis in the cross-region banks. It shows the powerful discriminating power when they apply the fuzzy DEA models.

The research

Research Aims

The study on bank efficiency is well-recognized in applied research literature. However, most of the studies have investigated the bank efficiency using Data Envelopment Analysis (DEA). After assessing of current status of the topic chosen, this study found that, it is not thoroughly discussed of the implementation of Fuzzy Data Envelopment Analysis (FDEA) especially in Islamic banks. Therefore, there is clearly a need for further research on this topic. This research also defined an efficiency of Islamic banks with an application of FDEA as '... a multi-disciplinary, team orientated, structured, analytical process and systematic analysis of function which seeks best value for Islamic banks to achieve it's objective as well as fullfill customer's needs.

The research aims to test, examine and rank the efficiency of Islamic banks across regions for the benefits of all, especially to Muslims in entire world. Hence, this paper will propose a conceptual framework of FDEA application in determining an efficiency if Islamic banks across regions.

The Research Questions

It is within the context of the above developments that the focus of the research is aimed at the key issue of how we learn from projects that have implemented with an application of FDEA. Whether its applications adhere to the accepted practices; how it is implemented and how to develop an acceptable framework of FDEA which will be used in detemine the level of efficiency of Islamic banks?

The Hypotheses

As driven by research questions, the research hypotheses are; the FDEA applications are only at an early stage of the implementation in Islamic banks; the FDEA is proven as one of the best Non-Stochastic Approach compared to DEA; FDEA application is following international practices in determine banks efficiency and this research will produce a general outline framework of Islamic banking efficiency with the implementation of FDEA.

The Objectives

Specifically, the objectives of the study is to implement FDEA in measuring Islamic banking efficiency; to test and examine the efficiency of Islamic banking and to rank and compare the efficiency of Islamic banking between regions.

Theoretical Framework of the Research

The outline framework which defines the research problem and related concepts of the research is as in Figure 1. The function of the selected particular issues stated in the conceptual framework was to identify a focus for the present research as well as to achieve the stated objectives.

Based on Figure 1, an objective to measure the efficiency of banks are achievable by applying FDEA. Literatures also shown that FDEA is started to be well accepted approach compared to DEA since it is capable of handling drawbacks of data compared to the traditional DEA approach and is able to find the interval for the fuzzy number efficiency score even if the correct efficiency score of the fuzzy number is unavailable.

Survey of the Previous Bank Efficiency Study

Empirical Application of Fuzzy DEA in banking

Empirical application of Fuzzy DEA has been found in a few studies. According to Kuo et al. (2006), the authors mainly discussed on commercial bank efficiency with fuzzy outputs and adopt fuzzy set theory to solve problems with the extension of DEA involving fuzzy elements, empirically found that the Fuzzy DEA approach is more appropriate, accurate and realistic approach to evaluate the efficiency of banks. Kuo et al. (2006) empirically investigated 19 commercial banks using fuzzy DEA. Finally, after considering fuzzy phenomena, the authors conclude that fuzzy DEA approach could not only successful characterize the uncertainty of efficiencies but also have the higher ability to discriminate bank's efficiency compared to traditional DEA model.

Moreover, Uemura et al. (2008) also discussed on fuzzy DEA model and its application to bank efficiency. After determining 11 banks, the authors have introduced notions of fuzzy production possibility area and crisp production possibility area. After that, they construct a fuzzy goal from each evaluation. The study had implemented CCR and BCR model, then compared the results with fuzzy DEA model. Regarding to the considering of fuzzy phenomena, the authors found that fuzzy DEA model can be easily calculated by solving a linear programming problem and proven that the efficiency scores generated by fuzzy DEA is more accurate with compared to CCR and BCC model.

Other than that, Li et al. (n.d.) has demonstrated the Chinese Commercial Banks based on fuzzy DEA model, specifically looking at X-efficiency analysis. There are 14 banks has been investigated with looking at cause analysis, which this analysis is closely related to X-efficiency theory where this theory believes that enterprise is composed by different interest groups, while different interest groups are composed by different individuals. Related to that, individual has choice rational, exists

psychological inertia religion and different individual pursues different interest, as well as some other factors such as environmental and management factors. 'Intermediary method' has determined staff number, and total assets as inputs, and deposits, loan, and profit before tax as outputs. From that, authors found that, six banks shown a highly efficiency banks where technical efficiency are higher that X-efficiency when membership is 0.9, which explain these six banks shown staff member's degree of effort is very high, while other banks show the efficiency is lower.

Wu et al. (2006) applied a fuzzy DEA model to determine the efficiency of 24 cross-region bank branches in Canada. The authors incorporating fuzzy environmental variables of income level, population density, and the economy, to assess the performance of bank branches from three different regions: Ontario, Quebec, and Alberta. The assumption made was that different regions may face different external environments that exert significant influence to the performance of different branches. The labels of the environmental variables were linguistic, i.e., "high", "medium", "very good" and "good."

All of inputs and outputs variables in Table 3 are derived through intermediation approach where specifically concentrating on Islamic banks. It probably because most of the studies views bank as an intermediary of financial services and assumes that banks collect funds (deposits and purchased funds with the assistance of labor and capital) and transform these into loans, investment and other income or assets. According to above analysis, most literature consider *total deposits*, *capital* and *fixed assets* are treated as inputs along with *total loans*, *investment* and *volume of income* are defined as measures of output. As reviewed by Tahir et al. (2009), they were using deposits as an input to measure the efficiency of banks in Malaysia. The intermediation approach may be more appropriate for evaluating entire Islamic banking institutions because this approach is inclusive of profit and /or funding expenses, which often account for between one-half and two-thirds of total costs being transform into outputs. Likewise, the intermediation approach may be finer for evaluating the significance of frontier efficiency for the profitability of financial institutions, since the minimization of total costs, and not just production costs, is needed to maximize profits (Iqbal and Molyneux, 2005).

The outline research paradigm which defines the research problem and related concepts of the research is as in Figure 2 and stated in the Table 1-4. This proposed conceptual framework was to identify a focus for the present research, which shown the link between DEA and FDEA approach as well as the determination of inputs and outputs variables.

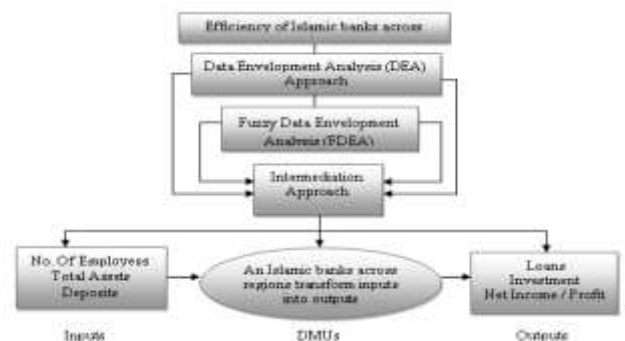


Fig 2. Outline of Research Paradigm in measuring Islamic Banking with an Implementation of FDEA Model

Figure 2 shown the connectivity between non-stochastic approach of DEA and FDEA; and how does the study determine the inputs and outputs. This study has used an intermediation approach since it is widely applied in deciding inputs and outputs variables (Mokhtar et al.; 2006).

In constructing the method of analysis, the study has considered the elements of weaknesses in DEA as discussed by literature and how it can be solved by inserting fuzzy elements. According to Lee et al. (2005), DEA is for measuring and evaluating the relative efficiencies of a set of decision-making units (DMUs) in terms of a set of common inputs and outputs. Traditionally, the data of inputs and outputs are assumed to be measured with precision, i.e., the coefficients of DEA models are crisp value. However, this may not be always true. There are many circumstances where precise inputs and outputs can not be obtained.

Therefore, in such situations, data of inputs and outputs can be represented by fuzzy numbers. They found the fuzzy advantage based on the dual program of DEA models, and have proposed fuzzy DEA models for CCR and BCC models. The researchers believed that fuzzy DEA models provide crisp efficiency with fuzzy input and output data. In addition, Saati et al. (2005) had found there are a several reasons why DEA result are not dependable. First, the efficiency obtained using DEA approach are sensitive to changes in sample size, input-output size, reference technology, etc. Second, they found that no formal performance judgement. Therefore, they makes an efficiency interval for each DMU where the intervals are ranked by fuzzy number ranking method. This shown that when fuzzy element is involved, that a DEA weaknesses almost resolved. Other than than, Lertworasirikul et al. (2003) also suggested the possibility approach of FDEA has a significant and high in flexibility for the researcher in comparing DMUs especially in a competitive and uncertain environment, this approach should enhance the capability of decision maker to improve their operations.

This paper employs the intermediation approach for special reasons. First, the study will be assessing the bank's efficiency as a whole. It means it will consider the dominant elements which will visualize the whole performance of the banks. Second, this approach is widely applied in determine bank's input and output (Kwan, 2002). Third, the main principle of Islamic banking itself is based on equity participation, i.e. employing funds on the basis of Profit and Loss sharing. This, by all means, implies the important of the intermediary activities that Islamic banks perform. Third, the financial institution is normally employing labor, physical capital and deposits as their inputs. This supported by Sealey and Lindley (1977) when they found that this approach is widely used in financial institutions and they normally employs labor, physical capital and deposits as their inputs to produce earning assets.

This study also viewing the determination of inputs-outputs based on summary in Table 2 and 3, most of Islamic banking study used an intermediation or asset approach while they investigating inputs and output determination. Moreover, according to Table 2, 3 and 4, and the above reasons, this paper has decided to consider (1) *Employees or Staff or Labor*, denoted by (X1), (2) *Total Assets*, which consist of fixed and current assets, denoted by (X2), and (3) *Deposits* which derived from deposit from other banks and customers, as an inputs to be evaluated, denoted by (X3), while outputs had determined as (1) *Loan* which the loan given to other banks and customers,

denoted by (Y1) (2) *Total Investment*, denoted by (Y2) and (3) *Net Income / Profit*, denoted by (Y3).

The Research Framework

Research design is the entire process of connecting the empirical data to the conclusions of the research; starting from the conceptualised of the problem until the data collection, analysis and the reporting process (Yin 1994; Creswell 1998). The function of the research design of this research (Figure 3) was to ensure that the evidence obtained by the research enabled the researcher to answer the research questions. Simulation project is also being pursued to examine the initial result of the study. This simulation will use real data. So that researchers can analyze correctly. Then, the initial model will be developed in accordance with the application of research models as methodology proposed.

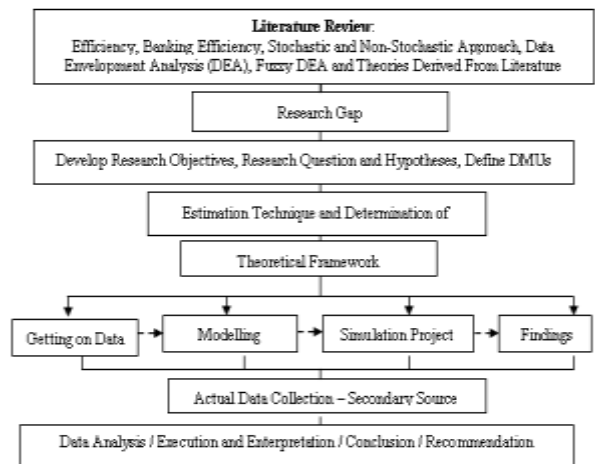


Fig. 3. Research Design

The following Figure 4 illustrates the conceptualisation map of the methodology transformed from the earlier figures (Figure 1-3) as the research advanced and evolved as it further elaborated, explained, discussed and supported the process of the research thoroughly. After analysis using two different methods, the study will be able to compare results obtained with previous findings. In fact, the study hopes that some recommendations will be able to submitted for future studies, especially studies involving the efficiency of Islamic financial institutions.

Basically, this paper will go through the balance judgement of DEA and FDEA. As stated by most literature, FDEA able to resolve the existing deficiencies in the DEA. Therefore, it is expected to provide a significant results in measuring the level of Islamic banking efficiency. This can be evidenced by a number of studies have been conducted (e.g: Saati et al. (2002); Lertworasirikul et al. (2003); Wen et al. (2009)).

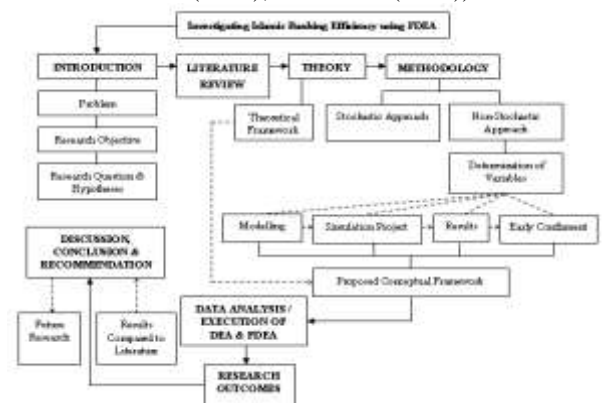


Fig. 4. Conceptualisation Map of the Methodology

Brief outline of research methodology

This section will explain the process involved in applying FDEA approach to Islamic banking. Basically, Figure 4 will demonstrate the process through four stages of relevant assessment, which ultimately will determine the ranking that explains DMUs level of efficiency being evaluated.

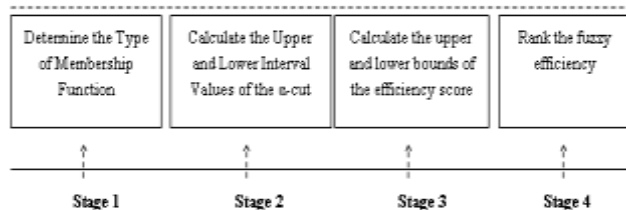


Fig. 5. Methodology Adopted for the Research

FDEA seen as one of the best approach to assess the efficiency of DMUs than DEA approach. As explained earlier, many researchers state that the FDEA able to give more accurate results because this method is not looking at the concept of '0' and '1'. However, able to look at the membership function sit between '0' and '1'.

Stage two will induce fuzzy space to calculate the upper and lower interval values of the α -cut. While stage 3 demonstrates the upper and lower bounds of the efficiency score of each DMUs investigated, and then repeat to find the upper and lower bound of the efficiency scores of all DMUs. The final stage will rank the fuzzy efficiency scores of all DMUs to find the better performing DMU only based on α -cut. Then, this study will use the model to measure the Islamic banks efficiency. Finally, the study will propose to all DMUs to increase efficiency in facing greater competition, especially in the banking industry.

Conclusion

In short, this study suggests a framework model for the study attempts to adapt the concept of Islamic banking with Fuzzy DEA. The rationale for this study choose the fuzzy element because its ability in assessing the efficiency of DMUs is more accurate and to overcome the shortfall of the DEA.

The Significance of the Research

It is hoped that the findings of this research would contribute to the efficiency, improvement and value of the output of the Islamic banking in international arena. At same time it will be able to reinforce the impetus for change in gearing towards globalisation, simultaneously, enabling the Islamic banking industry continues to thrive and well accepted as a reliable financial system and free from uncertainty. Another worthwhile dimension is with the proposed study to compare the DEA and FDEA will see exactly the level of Islamic banking efficiency which covers the whole world.

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Table 1: The Frequency of Inputs and Outputs Approaches; and Estimation Techniques Used

Inputs and Outputs Approaches	Frequency	Estimation Techniques	Frequency
Intermediation	34	DEA	32
Production	5	FDEA	6
Value-Added	5	SFA	23
User Cost	3	DFA	5
Assets	2	TFA	2
		FDH	1
TOTAL	49	TOTAL	63

Sources: Adapted from Ahmad Mokhtar, Abdullah & Alhabshi (2006) and authors' own updates
 Note: These results were found to be used in a review of 47 bank efficiency studies. Take note that the total number of techniques used in the previous studies are more than 47 studies since there are studies which used more than one technique. The same goes to the other findings.

Table 2. The Frequency of Inputs and Outputs Variables

Inputs Variables	Frequency	Outputs Variables	Frequency
Labor	45	Investment Securities	16
(Physical) Capital	33	Net / Total Loans	16
(Core) Deposits	18	Commercial Loans	13
Interest Expense	12	Real Estate Loans	13
Non-Interest Expense	10	Consumer Loans	13
Purchased Funds	6	Non-Interest Income	14
Time and Saving Deposits	6	Other Loans	11
Borrowed Funds / Money	6	Interest Income	9
Operating Expense	6	Demand / Saving Deposits	7
Demand Deposits	3	Time Deposits	7
Customer Funds	3	Earning Assets	5
Expenditure on Materials	3	Deposits Placements	5
Financial Capital	3	Securities in Trading	4
Transactions Deposit	2	Commitments and Contingencies	4
Non-Transaction Deposits	2	Short-Term Loans	3
Occupancy Costs	2	Long-Term Loans	3
Total assets	3	Installment Loans	2
Revenue	1	Earnings per Share (EPS)	1
Facilities	1	Brokerage Commission	1
Investment Level	1	Net Income	3
Area of the Branch	1	Operation Profit	1
Administrative Expenses	1	Profit of Other Activities	1
		Total Number of Insured Person	1
		Number of Insured Person's Agreement	1
		Total Number of Pension Receivers	1
TOTAL	168	TOTAL	155

Sources: Adapted from Ahmad Mokhtar, Abdullah & Alhabshi (2006) and authors' own updates

Table 3. The Frequency of Inputs and Outputs Variables in Islamic Banking using DEA Approach

Inputs Variables	Frequency	Outputs Variables	Frequency
Total Deposits	7	Total Loans	6
Capital	3	Investment	3
Employees / Staff Number	2	Income	3
Fixed Assets	3	Total Earning Assets	2
Salaries and Wages	2	Liquid Assets	1
Total Overhead Expenses	2	Other Income	1
Staff Cost	1	Loan Advances	1
Interest Expenses and Saving Deposits	2	Off-Balance Sheet Items	1
Non-Deposit Funds			
TOTAL	22	TOTAL	18

Source: Author's own updates

Note: These results were found to be used in a review of 9 Islamic banks efficiency studies.

Table 4. FDEA – Frequency of Inputs and Outputs Variables

Inputs Variables	Frequency	Outputs Variables	Frequency
Employees / Staff Number	4	Loan	3
Branch	1	Non-Term Deposit	2
Assets	1	Profit / Revenue	2
Total Fixed Assets	1	Investment	1
Deposits	1	Other Income	1
Equipment	1	Term Deposits	1
Occupancy	1	Mortgage	1
General Expenses	1	Profit Before Tax	1
Income Level	1		
Population Density	1		
Economy	1		
Total Assets	1		
TOTAL	15	TOTAL	12

Source: Author's own updates

Note: These results were found to be used in a review of 6 banks efficiency studies.