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Measuring efficiencies of Bangladeshi and Indonesian microfinance institutions: A data envelopment analysis and latent growth curve modeling approach

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Abstract

Purpose – The purpose of this paper is to measure the technical efficiency and growth trajectory of Bangladeshi and Indonesian microfinance institutions (MFIs). The motivation for this study was derived from crucial roles that these institutions play in the socio-economic transformation of any nations, especially Bangladesh and Indonesia which are at least prominent in the Asian context in this regard. Rather than "proving" impact, research endeavors have shifted to focusing on "improving" the impact of MFIs, because the ability to improve their impact as socio-economic transformation platform may be hinged on their efficiency over time.

Design/methodology/approach – Data were obtained from MIX market database covering a five-year period from 2007 to 2011 for 20 Bangladeshi and 11 Indonesian MFIs. The data obtained were subjected to both efficiency and trajectory analysis using data envelopment analysis (DEA) based on Malmquist productivity index, independent *t*-test, and latent growth curve modeling (LGCM).

Findings – Overall, DEA results indicate that both Bangladeshi and Indonesian MFIs are approximately efficient under constant returns to scale, variable returns to scale, and scale. There has been an improvement in the management practices of Bangladeshi MFIs, while Indonesian MFIs have increased in optimum size. Independent *t*-test result shows that Bangladeshi MFIs are significantly efficient in terms of performance and firm's size compared to Indonesian MFIs, but there is no significant difference in their efficiencies with regard to technology. The intercept and the slope of the regression weight in the estimated model using LGCM are not significantly different.

Research limitations/implications – This study measures technical efficiency and growth trajectory of Bangladeshi and Indonesian MFIs over a five-year period. However, future studies could explore this in greater depth by incorporating more data.

Practical implications – The research findings have great implications for the Bangladeshi and Indonesian MFIs. Since this study is among the first of its kind, the researchers have paved ways for further investigation in this area. Moreover, the study encourages the Bangladeshi and Indonesian MFIs to be more concerned of their efficiencies.

Originality/value – This study measures technical efficiency and growth trajectory of the Bangladeshi and Indonesian (MFIs). These have never been examined together in this way before.

Keywords Efficiency, DEA, MFIs, Independent *t*-test, LGCM, Mix market

Paper type Research paper

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1. Introduction

Microfinance institutions (MFIs) provide varieties of financial services to low-income earners who have no access to commercial banks' funding in the society (Servin *et al.*, 2012). Similar to other MFIs from other part of the world, the financial services offered by the MFIs in Asia are mainly designed to fit the clients' expectations with the specifications to assist the low-income earners to actively involved in productive activities (Mokhtar *et al.*, 2012). Arguably, the financial repression by the mainstream financial institutions has aggravated the incidence of financial exclusion of low-income earners who are considered as neither creditworthy nor bankable (Adewale, 2014). Apparently, MFIs have been very instrumental to assuage such financial exclusion by extending services, such as saving facilities, credit, and micro-insurance, to the low-income earners (Hassan *et al.*, 2012; Ylinen, 2010). Moreover, MFIs also seek social wealth maximization as compared to traditional financial institutions that pursue economic wealth maximization (Hassan *et al.*, 2012).

The development of MFIs with its unique characteristics that include double bottom line objectives of outreach to the poor and financial sustainability, in about four decades ago, was to provide alternative means for global poverty alleviation efforts (Widiarto and Emrouznejad, 2015). The importance of MFIs as a platform for poverty eradication and socio-economic growth has aroused the interest of researchers, stakeholders and government authorities (Apostolakis *et al.*, 2015); the significant roles of MFIs in the society are obvious and commendable because irrespective of the area through which the loan is being channeled, the poor and lower class people who are the main borrowers of these institutions appreciate them as a reliable source of finance. For example, Rosenberg (2010) stresses that the poor in the society appreciate microfinance for being helpful, especially in dealing with their vulnerability.

Meanwhile, there are a plethora of literature on MFIs which claim and counter-claim the efficacy of the MFIs *vis-à-vis* the impact they have on the individual, microenterprises, and society (Hermes and Lensink, 2011; Servin *et al.*, 2012). Lack of consensus in this regard has shifted the argument from proving impact to improving impact. Crucial to such discourse is an assessment of the efficiency of MFIs. As stated by Kyereboah-Coleman (2007), the major concern of MFIs' stakeholders (clients, employees, government, donors, creditors and owners) is the extent to which MFIs, notwithstanding the issues relating to their sustainability, have enhanced their operational efficiency. The yardstick for MFIs success is their actual performance in eradicating poverty; as such, the operational efficiency of MFIs has great implication for the outreach, sustainability, and impact. Meanwhile, the importance of studying the efficiency of Asian MFIs could be justified by the fact that, MFIs with the largest asset size are located in Asia; and they are here to complete the services offered by the traditional financial institutions. Also, several efficient MFIs are located in Asia in Asia due to their large population densities and lower wages (Haq *et al.*, 2010).

In Asia, Bangladesh and Indonesia are the giants and successful countries from the perspective of MFIs (Ahmed, 2009; Helms, 2006; Patten *et al.*, 2001). This is due to their tremendous success in providing financial services to the poor and the low-income earners (Estapé-Dubreuil and Torreguitart-Mirada, 2013). Ever since this claim by Ahmed and others, there is virtually no single study that combines MFIs from these countries with the aim of examining their efficiencies. This study fills this gap by analyzing the technical efficiencies of Bangladeshi and Indonesian MFIs. We also study their productivity change as well as changes in the technical efficiencies of Bangladeshi and Indonesian MFIs for a period of five years from 2007 to 2011. The study aims to make a distinctive contribution to the field of microfinance; it could also facilitate the policymakers' decisions on the Bangladeshi and Indonesian MFIs, and could be used as classroom discussions.

For several reasons, our study chose to apply data envelopment analysis (DEA)-based Malmquist approach on the Bangladeshi and Indonesian MFIs. First, the DEA model is suitable for the efficiency analysis of MFIs as it considers multiple outputs (i.e. gross loan portfolio and number of active borrowers) and multiple inputs (i.e. total assets and operating expenses). Second, DEA is potentially capable of providing accurate information to the management to improve productive efficiency of MFIs. Third, price information for dual cost function is not required for non-parametric DEA (Haq *et al.*, 2010). Also, profit maximization or cost minimization assumption is not required when using DEA-based Malmquist productivity index (MPI). Fourth, MPI allows the decomposition of productivity changes into technical efficiency change or catching up and technical change or changes in the best practice. Finally, specification of the functional form of frontier is not required for MPI because frontier could be biased if the functional form is incorrectly specified. The main disadvantage of MPI is the necessity to compute the distance functions. However, this problem has been solved by the DEA technique (Bassem, 2014; Hassan *et al.*, 2012).

We also use latent growth curve modeling (LGCM) to track the changes in efficiencies of Bangladeshi and Indonesian MFIs. Structural equation modeling (SEM)-based latent growth curve modeling (LGCM) is frequently used for analyzing longitudinal data (Kim *et al.*, 2015). The researchers chose to use LGCM over its competing methods, such as ANCOVA and multilevel modeling, because it permits investigation of inter-individual differences in change over time, antecedents, and consequences of change. LGCM enables the researchers to estimate the initial level of the efficiency and rate of changes over a specified time frame. Group-level statistics, such as mean growth rate and mean intercept, are provided by the LGCM, and it can be applied to test the hypotheses about specific trajectories by assessing practical and statistical significance of the model parameters. These approaches (DEA and LGCM) have traditionally been used to study the efficiency of MFIs, insurance, and banking (Babatunde and Haron, 2015; Bassem, 2014; Gutiérrez-Nieto *et al.*, 2007; Haq *et al.*, 2010; Hermes *et al.*, 2011; Hermes and Lensink, 2011; Hudon and Traca, 2011; Servin *et al.*, 2012; Wijesiri *et al.*, 2015; Yergin *et al.*, 2015).

The remaining part of the paper is structured as follows. The next section discusses literature on microfinance. Thereafter, the methodology employed for data collection and analysis is explained. The remaining sections are: findings, conclusion and implication of the study for research and practice, in that order.

2. Literature review

MFIs efficiency is the appropriate allocation of inputs resources to produce outputs. Kipesha (2013) argues that MFIs are not in focus in the past for three reasons. First, the focus of MFIs is on credit delivery which provides financial services to the poor in the society, where collateral is replaced with the accountability, mutual trust, participation, and creativity. Second, majority of the MFIs' projects are funded by the donors who measure the achievement of the projects through their social impact. Third, MFIs are ineffective when compared to traditional financial institutions due to their perceived underlying social philosophy as contrasted to the economic orientation of the latter. However, the need to assess the economic efficiency of different MFIs makes it possible to relatively compare the efficiency of firms that are sharing the same characteristics (Guerrero and Negrín, 2005). Moreover, according to Hassan *et al.* (2012), increase in technical efficiency of MFIs is crucial for the maximization of social wealth[1].

Stochastic frontier analysis – a parametric test – and DEA – a non-parametric test – are the widely used frontier methods when studying efficiency and productivity changes of MFIs (Wijesiri and Meoli, 2015). This study uses DEA in its quest to investigate the efficiency of Bangladeshi and Indonesian MFIs; as such, the discussion of literature in this section concentrates on the DEA analysis. One of the pioneer studies that use DEA to study

firm's efficiency is the study of Charnes *et al.* (1978); they propose an input-oriented model that assumes constant returns to scale (CRS). According to Charnes *et al.* (1978), a particular firm attains CRS when an increase in its inputs results in equal proportion to increment in the firm's outputs. However, a firm exhibits a decrease return to scale if an increase in the input results into a decrease in the firm's outputs. More so, an increase return to scale is achieved when input increment also results in increase in the firm's outputs. Since their pioneer study, different researchers have been using inputs and outputs oriented approaches to analyze the efficiency of different firms from different economic settings.

To start with, Tahir and Tahrim (2013) investigate the efficiency of MFIs from five ASEAN countries, including Cambodia, Philippines, Indonesia, Laos, and Vietnam from 2008 to 2011. Total assets and operating expenses are used as input variables, while gross loan portfolio and number of active borrowers are used as output variables in their study. According to the researchers, notable progress was noticed in the overall efficiency of MFIs over the period of the study – 69.7, 75, and 75.4 percent from 2008 to 2009, 2009 to 2010, and 2010 to 2011, respectively. Authors also indicate that Vietnamese MFIs are managerially efficient compared to other countries because they recorded highest mean efficiency score (86.7 percent); whereas, Laos recorded the lowest (43.8 percent), indicating that the Laotian MFIs are the least efficient compared to other MFIs from other countries.

Bassem (2008) analyze the efficiency of 35 MFIs for two years, from 2004 to 2005, in the Mediterranean zone using DEA. The author uses staffs and assets as inputs variables, whereas deposits and loans are employed as output variables; he finds that eight of the randomly selected institutions are relatively and technically efficient and that the size of MFIs negatively affects the firm's efficiency since larger MFIs are less efficient compared to medium-sized ones. As a result of this finding, author recommends that transaction costs and volume of activity of the large size MFIs should be reduced to be more effective in their mission.

In addition, Hassan *et al.* (2012) examine technical and scales efficiencies of the Middle East and North Africa (MENA) MFIs with the intention of tracking the sources of inefficiencies of the selected MFIs for a period of five years – 2000-2005. Authors employ both production and intermediation approaches of DEA. It was observed that the selected MFIs demonstrate low technical efficiency under the two approaches (production and intermediation). According to the authors, inputs resources are being wasted by the MFIs – input-oriented inefficient; and outputs, such as making a loan, raising funds, and obtaining more borrowers per staff, are not being produced enough by these firms. Moreover, the MPI of MFIs does not reveal any improvement in their efficiencies during the study period.

Furthermore, Ahmad (2011) investigates the efficiency of MFIs in Pakistan using both inputs and outputs oriented of DEA; his study comprises 12 MFIs in 2003 and 19 MFIs in 2009. Gross loan portfolio and the number of active borrowers are used as output variables, and total assets and number of personnel are used as input variables. It was found that three MFIs are efficient under constant return to scale, while four MFIs are efficient under variable return to scale (VRS) in 2003. Nevertheless, four MFIs are efficient under both constant return to scale and VRS in 2009. Ahmad argues that the efficiency of MFIs in Pakistan declined in 2009; he also showed that two MFIs found to be efficient in 2003 were non-existent in 2009. The author, therefore, concludes that MFIs in this country should provide services on sustainable basis and this could be achieved if they can profitably provide finance to microenterprises on an acceptable scale without relying on the use of subsidies, grants, or other concessional resources.

Ferdousi (2013) estimates efficiency and its determinants for three countries (Bangladesh, China, and India) using number of staffs and operating expenses as input variables, and gross loan portfolio and number of active borrower as output variables. The finding suggests that Bangladeshi MFIs enjoy higher economies of scale and have a

greater chance to be efficient under VRS, while Chinese and Indian MFIs are likely to be more efficient under constant return to scale. In addition, author also finds that inefficiency noticed in the sample countries is pure technical in nature; he, therefore, recommends an improvement in the management skills for all the MFIs by ensuring the efficient utilization of available inputs to enhance outreach and performance of MFIs.

More so, Olasupo and Afolami (2013) examine efficiency of MFIs in the South-West of Nigeria for a period of five years, from 2006 to 2010, using both inputs and outputs approaches of DEA. They find higher annual mean of technical efficiency scores for inputs-oriented DEA as compared to outputs-oriented DEA. Also, their slack estimation reveals potential increases of 5,425 clients in the number of borrowers and potential increases of 1,432 clients in the savers per staff member under the outputs oriented measures.

Haq *et al.* (2010) use DEA to investigate cost efficiency of 39 MFIs from Asia, Africa, and Latin America. They employ production and intermediation approaches with the aim of comparing and identifying the best performing MFIs in the area of cost minimization and rendering financial services to the poor. They find that non-government organizations (NGOs) MFIs are more efficient under production approach and bank-MFIs are more efficient under intermediation approach. However, they argue that the NGO-MFIs are less likely to perform better in the long run compared to the bank-MFIs due to the sustainability issues. Moreover, Kipesha (2013) evaluates the efficiency of Tanzanian MFIs (three non-bank financial institutions, eight NGOs, three cooperative banks, three microfinance companies, three community banks, and nine commercial banks offering microfinance services) under both production and intermediation approaches of DEA and unbalance panel data from 2009 to 2011. Kipesha's results reveal that average technical efficiency was higher under the production approach compared to intermediation approach.

Empirical studies on the productivity change (MPI) of MFIs are still in its infancy stage (Wijesiri and Meoli, 2015). Among the studies that examine productivity change of MFIs, Bassem (2014) uses DEA-based MPI to evaluate the productivity changes of 33 MENA MFIs. The author's study shows a decrease of 4 percent in the MFIs productivity during the period of the study – 2006-2011; this slight decline in productivity was attributed to technical efficiency change and regional uprising, known as the "Arab Spring." It was also found that the whole industry has experienced a decline in technological change by 2.9 percent over the study period; also, deterioration in the performance of the best practicing MFIs was reported by the author.

Hassan and Sanchez (2009) examine technical and scales efficiencies of MFIs in three regions: Latin America countries, MENA countries, and South Asia countries. Hassan and Sanchez also compared MFIs' efficiencies across these regions and across type of MFIs. They find that formal MFIs (banks and credit unions) are technically efficient compared to non-formal MFIs (nonprofit organizations and non-financial institutions). Furthermore, they reveal that South Asian MFIs have higher technical efficiency than Latin American and MENA MFIs, and the source of this inefficiency is pure technical rather than the scale. Moreover, Wijesiri and Meoli (2015) investigate the changes in productivity of 20 Kenyan MFIs for four years period from 2009 to 2012. Their results show that Kenyan MFIs have experienced about seven percent annual productivity progress on average and that was attributed to technological advances. Thus, DEA-based MPI is suitable for examining the efficiency of MFIs and productivity change across the period of study; however, it does not track the inter-individual change in the efficiencies of MFIs across two or more countries over time.

The present study extends the above literature. Using DEA-based MPI and LGCM which possesses all the advantages of SEM, including the ability to account for measurement error by using latent repeated measures, the ability to evaluate the adequacy of models using model fit indices and model selection criteria, and the ability to deal effectively with missing data (Preacher *et al.*, 2008), we examine technical efficiency and productivity change of

31 Bangladeshi and Indonesian MFIs within the period of 2007 to 2011. As shown in the next section and in line with other studies (Hassan *et al.*, 2012; Wijesiri and Meoli, 2015), we have used pure technical efficiency (PTE) and scale efficiency (SE) to investigate technical efficiency of the selected MFIs; and we also decompose MI into technical efficiency change (EFFCH) and technological change (TECHCH) to establish the sources of movement in productivity. We finally decompose technical efficiency change into pure technical efficiency change (PECH) and scale efficiency (SECH). In addition, we employ LGCM to estimate and explain initial efficiency level and the rate of change over time, and linking parameters of growth to the predictor (i.e. time varying and time invariants) variables, such as country type (in this case, Bangladesh and Indonesia).

3. Data and methodology

The present study focuses on Bangladeshi and Indonesian MFIs. We have chosen these countries because they are considered as giants in Asia from the perspective of MFIs (Helms, 2006). Also, they are both developing countries with several successful MFIs. The researchers investigate the efficiency of MFIs from these countries so as to ascertain their current situation. Our sample consists of 20 Bangladeshi and 11 Indonesian MFIs over a five-year period from 2007 to 2011 (155 observations). We have selected this time frame (2007-2011) since majority of MFIs, especially Indonesian MFIs, have not reported their data beyond this period. Thus, investigating the efficiency of Bangladeshi and Indonesian MFIs becomes possible using this time frame. The MFIs data are accessed from individual institutions as reported to microfinance information exchange, popularly known as mix market (www.mixmarket.org).

Mix market is a reliable database for MFIs data from every part of the world. Bassem (2014) describes mix market as a nongovernmental organization whose objective is to promote exchange of information on the microfinance sector around the world. For this period, 2007 to 2011; mix market collects information on 34 Bangladeshi and 16 Indonesian MFIs operating in accordance with international standards. However, the present study collects balanced data of 20 Bangladeshi and 11 Indonesian MFIs from mix market for this study. Since this study adopts DEA method, the choice of suitable outputs and inputs becomes crucial (Kao and Liu, 2004). The application of production approach or intermediation approach to examine the efficiency of MFIs depends on the choice of outputs and inputs variables. In the production approach, MFIs are viewed as the producers of outputs, such as gross loan portfolio and number of active borrowers, using inputs, such as total asset and operating expenses. Under the intermediation approach, MFIs are considered as the financial intermediary that mobilises funds from surplus units and channels them to the deficit units (Kipesha, 2013; Bassem, 2014).

The production approach dominates the MFIs technical efficiency because debt are used by most MFIs to provide loans to the low-income earners instead of deposits (Ahmad, 2011; Tahir and Tahrim, 2013). In line with other studies, such as Bassem (2014), Wijesiri and Meoli (2015), Wijesiri *et al.* (2015), and Jaiyeoba and Haron (2015), the researchers have employed two outputs: gross loan portfolio, number or active borrowers, and two inputs: total assets and operating expenses[2]. Table I summarises the meaning of outputs and inputs variables as collected from the mix market website. Since this study uses DEA-based MPI and LGCM to investigate technical efficiency, productivity change, and rate of change over time in the efficiency of Bangladeshi and Indonesian MFIs; the next three sections provide brief discussions on DEA, MPI, and LGCM.

3.1 DEA

DEA is a non-parametric method of data analysis which uses mathematical programming for frontier estimation (Ahmad, 2011). As indicated, any level below the frontier is

Variable	Unit	Definitions
Outputs		
Gross loan portfolio	US$	All outstanding principals due for all outstanding client loans. This includes current, delinquent, and renegotiated loans, but not loans that have been written off. It does not include interest receivable
Number of active borrowers	Number	Number of individuals or entities who currently have an outstanding loan balance with the MFI or are primarily responsible for repaying any portion of the Loan Portfolio, Gross. Individuals who have multiple loans with an MFI should be counted as a single borrower
Inputs		
Assets	US$	Total of all net asset accounts
Operating expenses	US$	Expenses related to operations, including all personnel expense, depreciation and amortization, and administrative expense

Note: Compiled definitions are taken from mix market, assessed in February 2016

Table I. Output and input definitions

considered as technically inefficient. In addition, the researchers also adopt output oriented in which efficiency of MFIs under the study are estimated by means of output given a level of input. For instance, if K decision-making units (DMU) use N inputs to generate M outputs, then the relative efficiency ratio of a given DMU as represented by K can be measured (Coelli, 1996; Ahmad, 2011). In the Equation (A1)[3], the weight of outputs of K to the sum of its inputs weight can be used to further explain the outputs oriented application.

The equations under appendix represents the quantity of the output (e.g. gross loan portfolio and number of active borrowers) produced by the MFIs using quantity of inputs (e.g. total assets and operating expenses). Equation (A1) can then be replaced by the Equation (A2) when the DMU maximize the efficiency ratio.

K from the Equation (A1) is the efficiency ratio of the DMU, where v_j and u_i represent the jth input weight and ith output weight. n from the equation stands for the number of inputs and m for the number of outputs; x_{jk} is the value of input j and y_{is} is the value of the output i for the DMU (Ahmad, 2011). For clarity purpose, DEA technical efficiency is estimated and presented in the subsequent section.

3.2 MPI

Following Färe *et al.* (1994), the researchers adopt the outputs oriented Malmquist productivity change index. The choice of adopting this measure is because increasing outreach occupied the interests of MFIs, i.e. providing credit to the low-income earners which commensurate with not only their social mission, but also toward sustainability and by collecting more revenues from lending. Furthermore, MFIs always have restricted amount of money and human resources, and they compete in an imperfect economic environment because MFIs markets are not as developed as their traditional financial institutions counterparts (Bassem, 2014; Nawaz, 2010). In order to provide definition for the Malmquist index, Färe *et al.* (1994) define output distance function at t in relation to two distinct time periods using Equations (A3) and (A4).

According to Färe *et al.* (1994), the distance function in Equation (A3) measures maximum change in the required output to make (x^{t+1}, y^{t+1}) realistic in relation to the technology at time t. Likewise, the distance function in Equation (A4) estimates the maximum change in output to make (x^t, y^t) feasible in relation to time t+1 technology. Hence, the output of the Malmquist Total Factor Productivity (TFP) index can be expressed as what is shown in Equation (A5).

In Equation (A5), those terms outside the brackets indicate the technical changes while those within the brackets estimate the progress in the technology between the period t and $t+1$ and they are called technological improvement. Thus, the efficiency and technical changes are represented in Equations (A6) and (A7).

3.4 LGCM

LGCM is used to investigate the trend or changes in the efficiency of Bangladeshi and Indonesia MFIs over the specified period of this study. This method is a suitable analytical tool for longitudinal data since it accounts for both within firm and between firm variance in addition to the means in the statistical model. The assumption of this analysis is that two growth components, intercept (the initial status) and slope (the change) in the efficiency measures, are not independent, but related (Marathe *et al.*, 2007).

The intercept parameter represents an individual firm's score on the outcome variable at the initial state while the slope parameter represents the individual firm's rate of change over the time period of interest (Byrne, 2001). Under this analysis, the outputs of CRS and VRS of production approach are used. Two models were set up using these outputs. It was assumed under the first model that the efficiency measurement will increase linearly with time for each firm with separate slope and intercept for each firm. In the second stage of the analysis, country was used as a predictor for the intercept and slope using dummy variable that take on "1" for Bangladesh and "0" for Indonesia[4].

4. Analysis

Following the discussions on how data are obtained and methods of analysis in the previous section, this section presents the estimated results in details. Descriptive statistics, DEA-based MPI, and LGCM are the main analyses presented by the researchers in this section. Additionally, independent *t*-test was used to compare the mean scores of Bangladeshi and Indonesian MFIs under the CRS, VRS, and SE; it has also been used to compare the mean scores of Bangladeshi and Indonesian MFIs under the technical efficiency change, technological change, pure technical efficiency change, SE change, and TFP change. Table II depicts descriptive statistics on the variables employed in DEA analysis including their average, standard deviation, minimum, and maximum values for the sample of 31 MFIs. The proxies used for output variables are gross loan portfolio and number of active borrowers,

Variable	Year	Average	SD	Min.	Max.
Outputs					
Gross loan portfolio	2007	54,846,593	142,166,985	391,429	532,024,502
	2008	67,725,106	174,570,092	456,889	647,938,718
	2009	76,108,523	193,068,539	644,706	817,389,833
	2010	85,223,997	211,874,990	695,286	939,129,906
	2011	89,097,665	214,769,123	920,710	920,685,919
Number of active borrowers	2007	671811	1779794	590	6397635
	2008	699615	1815986	608	6327250
	2009	651116	1676311	727	6430000
	2010	658350	1647637	550	6610000
	2011	641478	1589145	525	6580000
Inputs					
Assets	2007	75,489,570	206,630,801	567,676	941,270,138
	2008	88,264,559	240,415,966	665,847	1,117,815,461
	2009	105,617,829	289,315,661	951,414	1,411,363,085
	2010	121,204,495	340,008,819	1,108,364	1,713,365,603
	2011	122,131,975	330,239,525	1,340,687	1,647,022,564
Operating expenses	2007	6,772,769	16,801,435	108,842	64,511,379
	2008	7,835,938	18,686,457	127,279	65,092,032
	2009	8,454,016	20,352,962	76,128	81,866,903
	2010	10,160,082	24,320,771	200,630	104,250,286
	2011	10,557,325	25,269,058	136,775	108,096,390

Table II.
Descriptive statistics of variables (inputs and outputs)

while that of input variables are total assets and operating expenses. All, except number of active borrowers, are in US$.

As shown in the table, gross loan portfolio's mean, minimum, and maximum scores increase during the period of the study from 2007 to 2011 by about 63, 135, and 73 percent, respectively. The number of active borrowers' mean and minimum values depreciate by approximately 4.52 and 11.02 percent, respectively. However, maximum scores appreciate by 2.85 percent. Total assets' mean, minimum, and maximum scores increase by nearly 61.79, 136.17, and 74.98 percent, respectively. Operating expenses' mean, minimum, and maximum scores also increase by approximately 55.88, 25.66, and 67.56 percent, respectively. Although with little reduction in the number of active borrowers' mean and minimum values, it can be deduced from Table III that Bangladeshi and Indonesian MFIs utilized their inputs to generate outputs.

The average technical efficiency scores of 31 Bangladeshi and Indonesian MFIs covered in this study are reported in Table III. Since efficiency measurement is the basic component of MPI, Table III presents the efficiency of selected MFIs' scores under CRS, VRS, and scale. As mentioned, a particular firm is on the industry frontier in the associated year if it has unity (one) or more value. However, a firm is below the industry frontier or technically less efficient if it has less than 1 efficiency score. This implies that a firm is less or more efficient as its efficiency score is below or above 1 (Saad, 2012). The researchers focus on output-oriented efficiency of MFIs because it is related to the objective of providing more services to the poor. In most cases, the average scores of Bangladeshi and Indonesian MFIs under CRS, VRS, and scale are similar. They are both approximately efficient as their average scores are close to 1.

In order to examine whether the efficiency scores of the Bangladeshi and Indonesian MFIs differ significantly, we employ an independent *t*-test as presented in Table IV. Accordingly, it was ascertained that Bangladeshi MFIs' mean scores are significantly higher under constant return to scale, $t(8) = 4.90$, $p = 0.001$ and under scale, $t(8) = 5.36$, $p = 0.001$ compared to mean scores of Indonesian MFIs. However, there is no statistical significant difference in their VRS mean scores, $t(8) = 0.81$, $p = 0.442$. The results in Tables III and IV confirm to us that Bangladeshi MFIs are significantly efficient in terms of performance and

	2007	2008	2009	2010	2011
Bangladeshi MFIs					
Constant return to scale	0.90	0.89	0.89	0.93	0.94
Variable return to scale	0.92	0.89	0.91	0.96	0.96
Scale	0.98	1.00	0.98	0.97	0.98
Indonesian MFIs					
Constant return to scale	0.84	0.84	0.86	0.84	0.87
Variable return to scale	0.91	0.90	0.92	0.93	0.92
Scale	0.93	0.93	0.94	0.90	0.95

Table III. Average technical efficiency scores

Variable	Country	Mean	SD	Sig.	95% CI of difference
Constant return to scale	Bangladesh ($n = 4$)	0.9100	0.02345	0.001	0.03176 to 0.08824
	Indonesia ($n = 4$)	0.8500	0.01414		
Variable return to scale	Bangladesh ($n = 4$)	0.9280	0.03114	0.442	−0.02220 to 0.04620
	Indonesia ($n = 4$)	0.9160	0.01140		
Scale	Bangladesh ($n = 4$)	0.9820	0.01095	0.001	0.02964 to 0.07436
	Indonesia ($n = 4$)	0.9300	0.01871		

Table IV. Differences in average technical efficiency scores according to country

firm's size compared to Indonesian MFIs, but there is no significant difference in their efficiency as regard to technology.

The Malmquist TFP index is decomposed into technical efficiency change (EFFCH) and technological change (TECHCH) so as to determine the sources of the selected MFIs productivity growth. Technical efficiency (EFFCH) is efficiency change and this is related to the movement of microfinance industry toward the frontier (i.e. catching up), while technological changes (TECHCH) are the changes in the technological base of MFIs in terms of frontier shift (Bassem, 2014). Hence, the sources of growth in the Bangladeshi and Indonesian MFIs are due to EFFCH, TECHCH or both. As discussed, an average score of Malmquist TFP index and its components that are less than one indicate deterioration in the productivity, while above one implies an improvement in the productivity. Table V presents the average scores of Bangladeshi and Indonesian MFIs' Malmquist TFPCH index. According to the results in Table V, it is obvious that the main source of TFP growth for the Bangladeshi and Indonesian MFIs is due to their technical efficiency change (EFFCH), 2.02 percent increase for the Bangladeshi and 5 percent increase for the Indonesian MFIs over the period of study.

Contrary to the above finding, the Bangladeshi and Indonesian MFIs, on average, depicted 2.97 and 4.97 percent decrease, respectively, in their technological change over the period this study. Although Indonesian MFIs showed approximately 1 percent increase in their technological change at the end of year 2010, but this improvement had deteriorated with about 5 percent at the end of year 2011. Furthermore, the decline in productivity as a result of average score of technological change was offset by the average score of technical efficiency change, making MFIs to exhibit overall productivity gains. In addition, technical efficiency change (EFFCH) is decomposed into pure technical efficiency change and SE change. Over the period of the study, Bangladeshi and Indonesian MFIs showed contradictory results. We find that the Bangladeshi MFIs' PTE increased by 3.09 percent against the Indonesian MFIs' PTE which decreased by 1 percent. In contrast to the immediate finding, our results also show that the Bangladeshi MFIs' SE decrease by 0.98 percent as compared to the Indonesian MFIs that demonstrate increase in their SE by 4.95 percent. We, therefore, deduce that during the period of study, Bangladeshi MFIs have improved in their management practices; while Indonesian MFIs have improved in their optimum size.

The researchers also perform an independent *t*-test to determine whether the DEA-based Malmquist efficiency scores of the Bangladeshi and Indonesian MFIs differ significantly. As reported in Table VI, we find insignificant difference in the mean scores of the

Table V.
Average Malmquist productivity index scores

	2007-2008	2008-2009	2009-2010	2010-2011
Bangladeshi MFIs				
Technical efficiency change	0.99	1.01	1.05	1.01
Technological change	1.01	0.98	0.96	0.98
Pure technical efficiency change	0.97	1.03	1.06	1.00
Scale efficiency change	1.02	0.98	0.99	1.01
Total factor productivity change	1.00	0.99	1.01	1.00
Indonesian MFIs				
Technical efficiency change	1.00	1.03	0.96	1.05
Technological change	1.01	0.99	1.00	0.96
Pure technical efficiency change	1.00	1.03	1.00	0.99
Scale efficiency change	1.01	1.00	0.96	1.06
Total factor productivity change	1.01	1.02	0.96	1.01

Bangladeshi and Indonesian MFIs with respect to technical efficiency change, $t(6) = 0.22$, $p = 837$, technological change, $t(6) = 0.50$, $p = 0.633$, PTE change, $t(6) = 0.47$, $p = 0.654$, SE change, $t(6) = 0.33$, $p = 0.750$ and TFP change, $t(6) = 0.00$, $p = 0.1$. It can be concluded here that there is no significant difference in the average scores of the Bangladeshi and Indonesian MFIs' productivity gains over the period of study.

Lastly, we have used CRS' scores to perform LGCM. As reported in Figures 1 and 2, this analysis assumes that the efficiency measurement has increased linearly with time for

Variable	Country	Mean	SD	Sig.	95% CI of difference
Technical efficiency change	Bangladesh ($n = 4$)	1.0150	0.02517	0.837	−0.05195 to 0.06195
	Indonesia ($n = 4$)	1.0100	0.03916		
Technological change	Bangladesh ($n = 4$)	0.9825	0.02062	0.633	−0.04403 to 0.02903
	Indonesia ($n = 4$)	0.9900	0.02160		
Pure technical efficiency change	Bangladesh ($n = 4$)	1.0150	0.03873	0.654	−0.04191 to 0.06191
	Indonesia ($n = 4$)	1.0050	0.01732		
Scale efficiency change	Bangladesh ($n = 4$)	1.0000	0.01826	0.750	−0.06256 to 0.04756
	Indonesia ($n = 4$)	1.0075	0.04113		
Total factor productivity change	Bangladesh ($n = 4$)	1.0000	0.00816	1.00	−0.0346 to 0.0346
	Indonesia ($n = 4$)	1.0000	0.02708		

Table VI. Differences in average Malmquist productivity index scores according to country

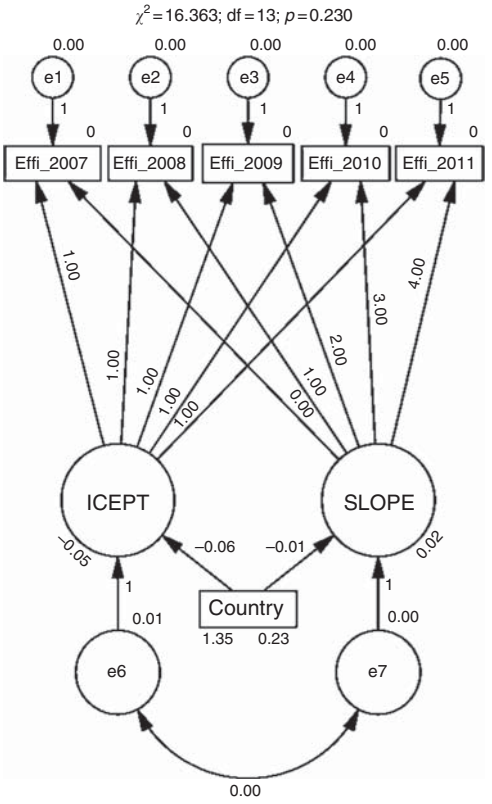

Figure 1. Unconstrained model

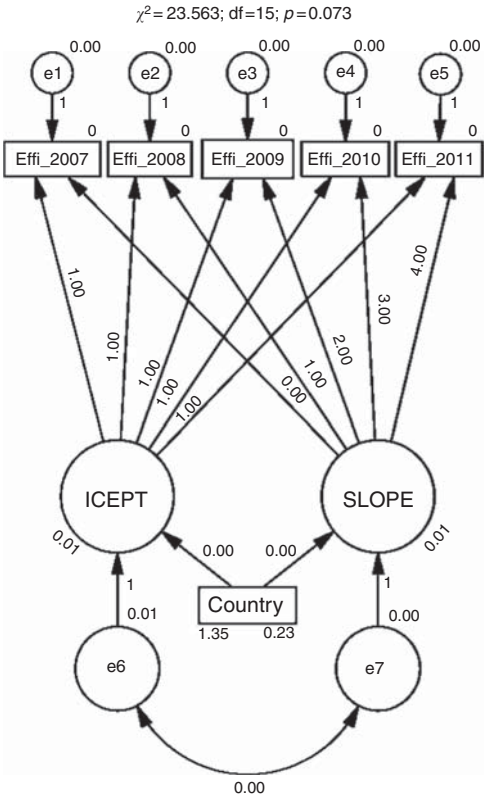

Figure 2.
Constrained model

each country's MFIs with separate slope and intercept. One important consideration from Figures 1 and 2 is to verify whether the models fit the data well. The χ^2 tests for the overall model fit of both unconstrained (default) and constrained are statistically insignificant indicating that the models fit the data absolutely well: unconstrained model, $\chi^2(17) = 20.142$, $p = 0.267$, constrained model, $\chi^2(19) = 26.971$, $p = 0.105$ (see Table VII for the assessment of models good fit). The high values of χ^2 in both models with their insignificant of asymptote p-values prove that we cannot reject this model. Thus, the models reflect true representation of the population.

Having established models fit, Table VII presents the result of the estimated parameters of the linear growth curve model with Bangladeshi MFIs as the time invariant predictor of the initial status (intercept) and the growth rate as depicted above in the unconstrained and constrained models. The intercept regression weight of 0.33 indicates that the Bangladeshi MFIs average efficiency scores are above their Indonesian counterpart with 0.33, while slope regression weight of 0.009 depicts an increase in the

Model	Unconstrained	Constrained
χ^2	20.142	26.971
df	17	19
Sig.	0.267	0.105

Table VII.
Model fit indices

efficiency scores of Bangladeshi MFIs over the years. However, the initial differences, as represented by regression weight of intercept, and the rate of tranjectory, as represented by the regression weight of slope, are not statistically significant enough for Bangladeshi MFIs to represent a predictor of the initial differences and rate of growth. Hence, the average efficiency scores of Bangladeshi MFIs are not significantly different from their counterpart MFIs from Indonesia. Moreover, the negative correlation between the unobserved endogenous variables of the intercept and slope indicates that the initial efficiency scores slowly decrease over time (Table VIII).

5. Conclusion

This paper examines the technical efficiency of Bangladeshi and Indonesian MFIs over a five-year period, from 2007 to 2011. The researchers applied three statistical measures to investigate the efficiency of these MFIs. First, DEA-based MPI is used to examine the efficiency and productivity change of Bangladeshi and Indonesian MFIs across the period of the study. DEA result indicates that both Bangladeshi and Indonesian MFIs are approximately efficient under CRS, VRS, and scale; while Malmquist result reveals that Bangladeshi MFIs have improved in their management practices and Indonesian MFIs have improved in their optimum size. Second, we applied an independent *t*-test to determine whether DEA-based Malmquist efficiency scores of the Bangladeshi and Indonesian MFIs differ significantly. We find that Bangladeshi MFIs are significantly efficient in terms of performance and firm's size compared to Indonesian MFIs, but there is no significant difference in their efficiency with regard to technology. However, there is also no significant difference in the average scores of the Bangladeshi and Indonesian MFIs' productivity gains over the period of study.

Third, LGCM, which is the application of the SEM, is used to track the inter-individual change in the efficiency scores of Bangladeshi and Indonesian MFIs. We also use this analysis to assess the moderating effect of MFIs-type as a time-invariant predictor of the initial status of trajectory of repeated measures of efficiency scores. Our estimated result of model comparison between the unconstrained and the constrained mode indicated that the regression weight of both intercept and the slope are not statistically significant. However, Bangladeshi MFIs, average efficiency scores are above their Indonesian counterparts; slope regression weight depicted an increase in the efficiency scores of Bangladeshi MFIs over the years of the study.

Overall, the need for MFIs in the modern world is enormous because there are higher percentages of poor people/low-income earners, especially in the Muslim dominated countries. Though much have been written about the importance of MFIs in the introductory part of this research; however, the cogent part is that MFIs ensure that the poor and low-income earners within the society get access to finance. With its microcredit, MFIs enable the poor to be engaged in economic activities that help them to accumulate capital and improve their standard of living (Mokhtar *et al.*, 2012). Moreover, MFIs should be

Effect	Model
Intercept (mean)	0.85***
Slope (mean)	0.020
Correlation (intercept and slope)	−0.465
Bangladeshi MFIs (mean)	1.35***
Bangladeshi MFIs (variance)	0.22***
Intercept on Bangladeshi MFIs	0.33
Slope on Bangladeshi MFIs	0.009

Note: ***This indicates 1 percent significant level

Table VIII. Linear growth curve with Bangladeshi MFIs as a predictor

efficient in rendering their services sufficiently. For this reason, this study highlights that government support for these institutions is important in both countries. For example, there are cases in which some previously efficient MFIs cease to exist due to the lack of financial support, especially from the government (Ahmad, 2011). More so, the philanthropists in the society and sufficient human beings should not relent in their support for these institutions for them to remained efficient in their operations and beneficial to the society.

Notes

1. Refer to study by Farrell (1957) and Widiarto and Emrouznejad (2015) for more details.
2. This study adopt the DEA approach, and the underlying theory of this approach is not limiting or restricting how variables should be selected as well as number of variables to be included in a model; however, the specification of the model in this study has generally been made from extant literature and from the rules of good senses which are not resting on statistical or theoretical criteria.
3. All equations are shown under the appendix.
4. LGCM equation (programming) beyond the scope of this study.

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Appendix

$$TE_K = \frac{\sum_{i=1}^{m} u_i\, y_{is}}{\sum_{j=1}^{n} v_j\, x_{jk}} \tag{A1}$$

$$TE_K = \frac{\sum_{i=1}^{m} u_i\, y_{is}}{\sum_{j=1}^{n} v_j\, x_{jk}} \leqslant 1, \tag{A2}$$

$$u_i, v_j \geqslant 0, j = 1, \ldots, n, \quad i = 1, \ldots, m$$

$$D_0^t\left(x^{t+1}, y^{t+1}\right) = \inf\left\{\theta : \left(x^{t+1}, y^{t+1}/\theta\right) \epsilon S^t\right\} \tag{A3}$$

$$D_0^{t+1}\left(x^t, y^t\right) = \inf\left\{\theta : \left(x^t, y^t/\theta\right) \epsilon S^{t+1}\right\} \tag{A4}$$

$$M_0\left(x^{t+1}, y^{t+1}, x^t y^t\right) = \frac{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_0^t\left(x^t, y^t\right)} \left[\frac{D_0^t\left(x^{t+1}, y^{t+1}\right)}{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)} D_0^t\left(x^t, y^t\right) / D_0^{t+1}\left(x^t, y^t\right)\right]^{1/2} \tag{A5}$$

$$\text{Efficiency change} = \frac{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_0^t\left(x^t, y^t\right)} \tag{A6}$$

$$\text{Technical change} = \left[\frac{D_0^t\left(x^{t+1}, y^{t+1}\right)}{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)} D_0^t\left(x^t, y^t\right) / D_0^{t+1}\left(x^t, y^t\right)\right]^{1/2} \tag{A7}$$

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