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Revisiting efficiency of microfinance institutions (MFIs): an application of network data envelopment analysis

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ABSTRACT

In order to achieve financial inclusion objectives of Sustainable Development Goals (SDGs) and provide continuous financial support to the unbanked population, microfinance institutions (MFIs) must attain efficiency in their operations. Hence, the main purpose of this study is to examine various efficiencies of MFIs based on their goals and operational mechanisms. By utilizing a unique production process and network data envelopment analysis (NDEA) technique, we estimated three different types of efficiencies (operational, financial and outreach) of 90 MFIs from 2013 to 2018. It was discovered that the overall efficiency of the MFIs was not up to the required standard and it became even worse when the financial and social outreach efficiencies were considered. However, operational efficiency (ability to generate intermediaries) was relatively better and remained high among the regulated MFIs. On the contrary, the financial and social outreach efficiencies were found to be better among the unregulated MFIs. Moreover, our results also highlight the divergence in efficiency between regions, legal status and regulatory environment; with projection analysis suggesting a simultaneous reduction in input, and an increase in output of inefficient MFIs to facilitate their attainment of efficiency. Policy implications are subsequently discussed.

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1. Introduction

The importance of financial inclusion—easy access to useful and affordable financial products and services, has gained considerable attention among the policymakers and practitioners due to its proven effect on the improved wellbeing of the poor. However, we are still far away from the realization of the 'financial inclusion for all' goal by 2030, as 1.7 billion adults remain unbanked as of 2017 (World Bank, 2020). One of the reasons for a large number of unbanked adults and low level of financial inclusion in many parts of the world is owing to the reluctance of formal financial institutions to render financial services to the poor, as it is deemed to be non-profiteering (Mia, Lee, et al., 2019). This is why the emergence of microfinance and its

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expansion to many countries is crucial to the upliftment of commercially excluded people (Haque et al., 2019). Consequently, MFIs are now being operated in a minimum of 120 countries globally and owing to its unique mechanism of rendering financial services to the poor, many people perceived the institution as a potential solution to the problems of financial inclusion of the world's unbanked population (Brown et al., 2016; Chibba, 2009; Mader, 2018).

Although microfinance remains a lucrative option towards achieving financial inclusion, it is not uncomplicated. As an instance, most of the microfinance institutions (MFIs) were initially socially driven, with the provision of financial services to the poor and unbanked as a prime objective (Kang et al., 2019; Rambu Atahau et al., 2020). However, with the advent of time and remarkable changes in the industry; attaining financial sustainability became a theme among the policymakers, managers and practitioners (Mia & Lee, 2017; Serrano-Cinca et al., 2016). Since financial sustainability is comprehensive and relatively new in the context of microfinance, attaining it becomes challenging to many MFIs due to their unfamiliarity with the concept. However, studies exist which recommend attainment of efficiency via the utilization of scarce resources in MFIs; and could be one of the successful ways to achieve sustainability (Balkenhol, 2007).

It is also widely believed that efficient or financially sustainable MFIs can alleviate poverty, and reach out to the unbanked and economically-disadvantaged population faster than the inefficient ones via the spill-over effect (Shankar, 2007). Moreover, Gustafson (1994) reiterates that a sustainable institution: '… produces outputs that are sufficiently in demand for enough inputs to be supplied to continue production at a steady or growing rate'. Nonetheless, Singh et al. (2013) also highlighted that banks and MFIs are judged based on how efficiency is easily achieved in their operations. Evidently, efficient and productive MFIs will tend to provide better products and services to the poor at low costs, which will subsequently enhance their wellbeing (Mia & Ben Soltane, 2016).

In view of this, MFIs need to achieve efficiency in their operations for an uninterrupted flow of financial services to the masses (Ullah et al., 2019). Nonetheless, attaining efficiency becomes crucial in the current context because donors, funders and investors now require MFIs to be self-sustainable, and operate without donations or concessionary funds as these sources have become insufficient. At this point, utilizing the scarce resources efficiently becomes a priority for the managers of MFIs, who require specific guidance on efficiency improvement. Moreover, ensuring resource efficiency will facilitate achievement of the intended dual objectives of MFIs—which is to achieve a wider coverage via financial inclusion (i.e., extend quality services to the poor) and attain self-sustainability (financial viability).

Hence, the objective of this study is to evaluate the efficiency of MFIs by considering a Network Data Envelopment Analysis (NDEA) approach; which according to the author's knowledge, has been applied to none or a very few studies in the microfinance research. This is not to say that this study is the first to evaluate the efficiency of MFIs; but rather, a large number of studies abound that have successfully evaluated the efficiency of MFIs in a single country, regional or at a global level: Ayayi and Wijesiri (2017); Fall et al. (2018); Gutierrez-Goiria et al., 2017); Kaur (2016); Kumar

and Sensarma (2017); Mia, Dalla Pellegrina, et al. (2019); Piot-Lepetit and Nzongang (2014); Wijesiri and Meoli (2015); Wijesiri et al. (2015).

However, our study differs in many ways from the existing literature cited above. First, we consider a unique three-divisional production process that was based on the notion of the intermediation approach, and has been largely ignored in the existing microfinance efficiency literature. Majority of the above-mentioned studies considered the production process of MFIs as a single black-box, where the efficiencies of inner divisions were unknown. By applying the multiple-stage production process, the efficiency of MFIs as intermediary institutions can be ascertained. This is very crucial as MFIs have to generate a large portion of their financial capital by employing market-based instruments, rather than relying on the traditional donors in recent years. Second, the novelty of the approach employed in this study lies in the ability to identify ways for potential improvements. It will be a great feat on the part of the managers of MFIs to gain insight on specific ways to achieve efficiency; either by reducing input, increasing output or a combination of both. Third, we made a comparison of efficiency levels among various MFIs based on regulation, legal status, and regional location, capable of facilitating prompt efficiency-related decisions by the policy-makers and regulatory authorities. Fourth, this study utilizes a very recent dataset (up to 2018) from the World Bank, with the majority of the earlier researches utilizing data only up to 2015, consequently enabling fresher evidence of MFIs efficiency from the global perspective.

The remainder of this paper is organized as follows: Section 2 presents a review of related literature; Section 3 discusses the research design comprising data, methods and techniques; Section 4 involves discussion of results; and finally, Sections 5 and 6 conclude with policy implications and, limitations and suggestions for future research respectively.

2. Literature review

Efficiency in microfinance refers to the ability of MFIs to transform inputs into outputs by either maximizing outputs with given inputs, or minimizing inputs with given outputs; which has become a subject of discussion lately (Balkenhol, 2007). With the increasing number of MFIs now reaching the poor globally, it becomes imperative to understand the dynamics of efficiency of MFIs in providing financial services to the poor. Furthermore, having a greater insight into the efficiency of MFIs would facilitate better funding decisions by governments and donors (Wijesiri et al., 2015).

Till date, there exists a number of studies that have successfully evaluated the efficiency of MFIs by focusing on different regions, contexts, sample periods and methods. In terms of methods and approach, previous studies have employed ratio analysis, parametric and non-parametric techniques; with the latter accounting for the majority of existing literature. To be more specific, most of the MFIs' efficiency studies utilized a parametric technique known as the Stochastic Frontier Analysis (SFA) and a non-parametric technique known as Data Envelopment Analysis (DEA); with both methods having their advantages and disadvantages.

To the authors' knowledge, relatively little evidence exists on the usage of the SFA technique in the estimation of the efficiency of MFIs. Among others, Hermes et al. (2011) and Servin et al. (2012) adopted the SFA technique in estimating the efficiency of MFIs, where the MFIs were assumed to produce a single output as the dependent variable for functional estimation. In contrast, the DEA was used extensively in the literature to measure the efficiency of MFIs (Ayayi & Wijesiri, 2017; Gutierrez-Goiria et al., 2017; Kaur, 2016; Kumar & Sensarma, 2017; Mia, Dalla Pellegrina, et al., 2019; Piot-Lepetit & Nzongang, 2014; Wijesiri & Meoli, 2015; Wijesiri et al., 2015). The DEA utilizes mathematical programming to estimate efficiency, which requires multiple inputs and outputs (Charnes et al., 1978).

Since a trade-off exists between the dual objectives of MFIs—financial sustainability and social outreach (Awaworyi Churchill, 2018, 2020), Hermes et al. (2011) subsequently utilize the SFA technique in the analysis of the overall efficiency of MFIs and their outreach to the poor. It was evidenced from the literature that a trade-off exists where social outreach is negatively related to efficiency, indicating the inefficiency of the MFIs focusing on lending to the poor. Servin et al. (2012) also employed the same SFA approach to examine the efficiency of MFIs based on its different ownership by utilizing data from 18 Latin American countries. Their findings revealed that the NGOs and cooperatives incurred lower interfirm and intrafirm efficiencies compared to the banks and non-bank financial institutions, which stemmed from the usage of lower technology.

By utilizing the DEA technique, Piot-Lepetit and Nzongang (2014) developed a benchmarking approach and performance indicators aimed at lowering the trade-off between financial sustainability and poverty outreach of the MFIs in Cameroon. The findings revealed the presence of a trade-off for 15% of MFIs. Similarly, Kaur (2016) employed the DEA in examining the role of efficiency in reaching the women and the poor in India. The results suggested that the average financial efficiency (at 84%) was higher than the social efficiency of MFIs which was rated at 32%. This finding confirms the speculation that the MFIs focused more on financial goals as opposed to a social mission. Going a step further, Wijesiri et al. (2015) employed a two-stage double bootstrap DEA approach and discovered that older MFIs in Sri Lanka were inefficient in terms of poverty outreach, subsequently indicating a mission drift as they tended to diversify their portfolio from initially targeted customers to relatively wealthier ones. Their findings also revealed that the type of MFI (whether NGO or non-NGO) does not influence financial efficiency.

Using a seemingly unrelated regression, Gutierrez-Goiria et al. (2017) analyzed the determinants of social and economic efficiencies of MFIs in different regions, ages and legal statuses. The results indicated that legal status was essential in obtaining greater economic and social efficiency. In contrast to the discovery of Servin et al. (2012), their results from a 'legal status' point of view indicated that banks were linked to lower economic and social efficiency, while NGOs were linked to the highest efficiency in both dimensions. More recent findings by Adusei (2019) from utilizing a sample of credit unions, banks, non-bank financial institutions, rural banks and NGOs; suggested that apart from board gender diversity, credit union MFIs were the most technically efficient. Nevertheless, the legal status of MFIs has an impact on social efficiency since NGO-MFIs are more socially oriented than their counterparts.

In another study, Wijesiri et al. (2017) examined the impacts of age and size on financial and social efficiency using a bootstrap meta-frontier DEA methodology based on several regions and discovered that age and size influenced both aspects of efficiency. The older MFIs, though financially efficient compared to the younger ones due to better market penetration, are inefficient in achieving outreach goals. Their results also indicated that larger MFIs tend to have higher financial and social efficiencies owing to their higher economies of scale. In a similar view, Adusei (2019) also observed the effect of size on the efficiency of MFIs, with the larger MFIs being technically efficient than smaller ones.

Utilizing data from 99 non-profit MFIs (NGOs and cooperatives), and applying the dynamic DEA that takes the inter-temporal activities between two time periods into account; Ayayi and Wijesiri (2018) discovered that most non-profit MFIs with lower average efficiency tend to be inefficient. By employing the stochastic distance function approach, Kumar and Sensarma (2017) analyzed the efficiency of MFIs via consideration of multiple outputs and inputs. They discovered that a trade-off existed between efficiency and outreach, particularly in reaching out to the poor. Moreover, Mia, Dalla Pellegrina, et al. (2019) investigated the link between outreach (financial inclusion) and efficiency of 122 MFIs employing the dynamic slack-based DEA method. Consistent with Wijesiri et al. (2015), their results suggested a mission drift of MFIs in Bangladesh from reaching the poor, in areas where most MFIs are operationally inefficient. Furthermore, it was observed that regulations imposed constraint to MFIs and reduced their overall efficiency. Interestingly, they also discovered that higher financial inclusion led to greater efficiency.

Recently, Hossain et al. (2020) analyzed the impact of competition on the economic sustainability and social performance of 1139 MFIs from 2005 to 2014, utilizing the random effect generalized least square method. They found strong evidence that competition has a negative and significant effect on the economic sustainability of MFIs, which is in contrast to the neo-classical competition theory, which suggests that competition enhances efficiency/sustainability. Interestingly, with respect to social performance, they discovered that competition has a negative impact on the breadth of outreach, but a positive impact on the depth of outreach of MFIs.

Zainal et al. (2020) examined the role of regulation and supervision on the social and financial efficiency of MFIs in ASEAN-5 countries. The estimation methods used in the study include DEA, panel regression and generalized method of moments. The results indicate that MFIs have lower social efficiency and greater financial efficiency, suggesting a mission drift of MFIs in poverty eradication. Furthermore, bank regulation and supervision are inadequate to meet social needs, thereby hindering the MFI's effort to eradicate poverty.

To summarize the development of efficiency and productivity research in microfinance, Fall et al. (2018) utilized quantitative synthesis of the literature and provided empirical evidence using meta-analysis of Mean Technical Efficiency (MTE) obtained from 38 studies. Their findings revealed that the efficiency of the microfinance industry was weak, with approximately 61.1% MTE. They further pointed out that MFIs have utilized more resources to attain outreach goals.

3. Research design

3.1. Sample selection and data source

Since the main purpose of this study is to estimate efficiency, MFIs institutional data were obtained from a secondary source named Microfinance Information Exchange, Inc (MIX). Previously independent, the MIX currently uses the World Bank online platform to release its extensive data of global MFIs[1]. The data are publicly available and can now be accessed at no cost for a wide range of MFI-related information; including their organizational, financial and social outreach data for 121 economies. These data are voluntarily submitted by the MFIs across the world on a quarterly basis, standardized and validated by MIX before it is published online. Several studies in the past have utilized this data source owing to its extensive global coverage, reliability and authenticity (Abdullah & Quayes, 2016; Mia & Ben Soltane, 2016; Quayes, 2015). The MIX had been obtaining the data since 1996, with the recent release covering data up till 2019 (only a few MFIs data were available for 2019).

This study was initially planned to cover the maximum number of MFIs (the decision-making units (DMUs) for efficiency analysis) and a recent period to obtain better representativeness of the sample and efficient estimates; however, few criteria had to be employed in selecting the final sample and the period. As an instance, the DEA method required that each input and output is observed throughout the sample period, indicating there should be no missing values. A second decision was to select either balanced or unbalanced panel data. Balanced data is a set of data where all elements are observed throughout the entire time frame, while unbalanced data is a set of data in which the data category is not observed during certain years. Although DMUs can be unbalanced to estimate efficiency; however, consistent result will be lacking should the sample size vary over time. Given a varying number of MFIs being reported in MIX from year to year, a large balanced panel sample was considered after which an appropriate filtering technique followed.

Considering the period, our goal was to utilize the recent data in the analysis; with initial filtering (for balanced panel data) resulting in a total of 311 MFIs between 2013 and 2018. After filtering the missing data, we were left with 90 MFIs having the complete data for all required input and output variables chosen in this study. Hence, the final sample included a total of 90 DMUs with a period of 2013-2018 and excluded the possible effects of the 2007–2009 global financial crisis that may alter the efficiency of MFIs. Yet, the sample size remains well above the minimum threshold to run the DEA (Boussofiane et al., 1991; Bowlin, 1998; Dyson et al., 2001; Golany & Roll, 1989). In terms of selecting DMUs, Sarkis (2007) presented two views on the determination of the appropriate sample size in DEA analysis. The first assumption was that larger sample size will generate a more reliable and efficient frontier, and substantially improve the discriminatory power of the efficiency analysis (Mia et al., 2018). Secondly, it is also widely assumed that large number of DMUs may decrease homogeneity and increase the influence of exogenous variables or other factors that may impact the overall efficiency results (Golany & Roll, 1989; Mia et al., 2018). Thus, moderate sample size or DMUs is often preferred in the estimation of efficiency.

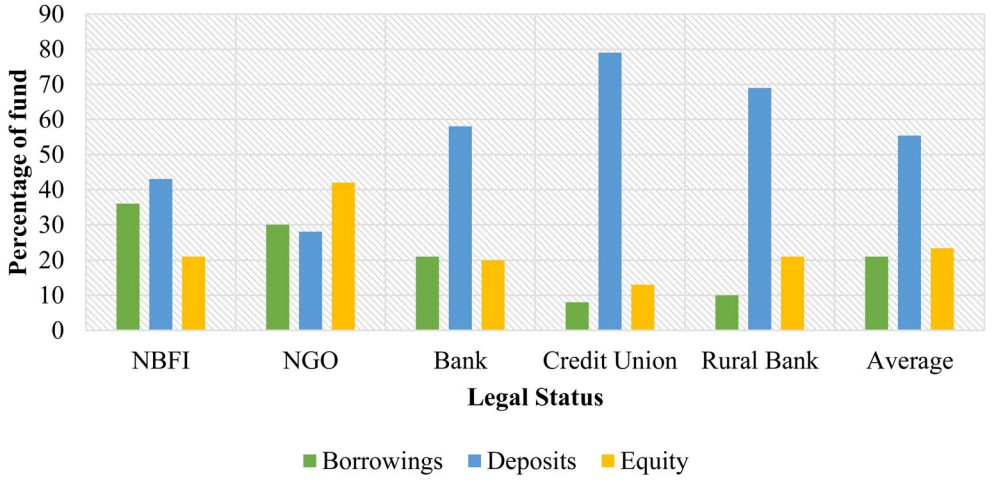

Figure 1. Funding structure of MFIs based on legal status.
Source: Authors based on FinDev (2020) Gateway report.

Our final sample size was also determined by the adopted production process in the study. As an instance, only MFIs that have employed all three types of funds in their operation (i.e. deposit, equity and debt) were selected. Since there exist MFIs that are ineligible to generate deposits or borrow from the secondary market (debt or equity) due to their local and regulatory setting, they were excluded from our analysis as DEA recommends that all the inputs and outputs should have positive values. Hence, our sample encompasses only those that can operate as an intermediary between savers and lenders; and raise funds from commercial sources in line with the production process (see next section for more detail).

3.2. Network production processes for microfinance institutions

To estimate the efficiency of MFIs, a unique three-division production process was considered which was guided by the MFIs' overall activities – operational efficiency, financial sustainability efficiency and social outreach efficiency. By considering these divisions, this study creates a better understanding of how inputs generate intermediary outputs, and also the efficiency of these intermediary outputs in the achievement of the dual objectives of MFIs. While this may not be the production mechanism for all MFIs, funding shortage and regulatory aspects availed many MFIs the liberty to rely on commercial funding. This is evident as deposits became a leading source of capital in the microfinance industry (Mia, 2017). Moreover, via gradual transformation of the microfinance industry and conformance to market principles, MFIs raised capital from depositors, commercial lenders and even the equity market; courtesy of the improvement of the regulatory environment over the years (Fernando, 2004).

Our classification is also in line with the categorization of the two types of MFIs: that which transforms input directly to output, and another utilizing the intermediation approach by working as a matchmaker between surplus and deficits units (Balkenhol, 2007). Since the majority of the existing literature focused on the first

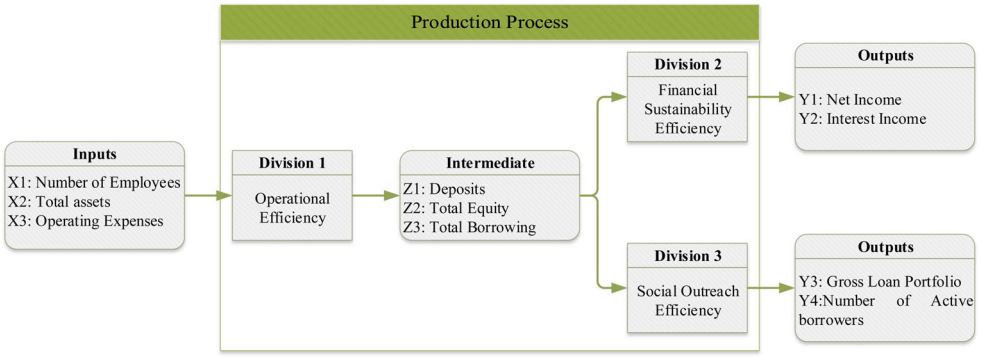

Figure 2. The network efficiency measurement framework for MFIs.
Source: Authors.

type of MFIs in evaluating productivity and efficiency, our study uniquely relies on the second type that outsources all its financing needs by exploiting the three main market-based instruments, viz. deposit, debt and equity. Since funding remains crucial in the microfinance industry (Tchuigoua et al., 2017), these three sources of funds should be regarded as an important part of the production process of MFIs. Figure 1 shows the usage of these three different sources of funds among various types (based on legal status) of MFIs in the global microfinance industry.

Based on the above, three inputs commonly used by the MFIs to render its services were considered, namely: number of personnel (Bibi et al., 2018; Gutiérrez-Nieto et al., 2009), total assets (Gutiérrez-Nieto et al., 2009) and operating expenses (Gutierrez-Nieto et al., 2007, 2009). In estimating operational efficiency, three intermediaries utilized by the MFIs were also considered, namely: deposits, total equity and total borrowing (debt). These intermediaries were the main inputs used by the MFIs in its attainment of the dual objectives of financial sustainability and social outreach in the subsequent divisions. The selection of these variables was also guided by the notion of the intermediary approach which aimed at collecting deposits to grant loans (Sealey Jr & Lindley, 1977).

Since the objective of microfinance programs had transformed from being subsidy driven to market-based, it follows that MFIs will be gradually wiped out from the market should they fail in their attainment of financial sustainability (Chikalipah, 2017). Hence, there is a need for MFIs to generate sufficient revenue/profit from its operations to reduce dependency on subsidized funds/donations, as these funds tend to be very limited and have become highly competitive in the recent years (Mia, 2017). To capture financial sustainability and social outreach efficiencies, two outputs for each of the category guided by the earlier framework of Yaron (1994) were considered. On one hand, the net and interest income were used to capture financial sustainability aspects of MFIs congruent with the existing literature (Gutierrez-Nieto et al., 2007). On the other hand, the gross loan portfolio (Gutiérrez-Nieto et al., 2009) and the number of active borrowers (Hartarska et al., 2013; Wijesiri et al., 2017) were used to capture social outreach dimensions of MFIs.

While studies that have observed trade-off (Annim, 2012; Cull et al., 2007) and no trade-off exist (Nurmakhanova et al., 2015), Hermes et al. (2011) justified why such

Table 1. Definitions of variables used for efficiency analysis.

Variable	Symbol	Definition	Unit
Input			
Number of personnel	X1	The number of individuals who are actively employed by an MFI.	Number
Total asset	X2	Total value of resources controlled by the MFIs as a result of past events and from which future economic benefits are expected to flow to the financial institution.	USD
Operating expense	X3	Includes expenses not related to financial and credit loss impairment, such as personnel expenses, depreciation, amortization and administrative expenses.	USD
		Intermediate	
Deposits	Z1	The total value of funds placed in an account with an MFI that are payable to a depositor including current / transactional accounts, term accounts, interest bearing accounts, and e-money accounts.	USD
Total equity	Z2	The residual interest in the assets of the financial institution after deducting all its liabilities.	USD
Total borrowing	Z3	The principal balance for all funds received through a loan agreement.	USD
		Output	
Net income	Y1	Total revenue minus total expenses during a given period, including operating and non-operating.	USD
Interest income	Y2	Interest generated by the loan portfolio net of any expense to reduce accrued interest if the collection of that interest is considered uncertain.	USD
Gross loan portfolio	Y3	All outstanding principals due for all outstanding client loans including current, delinquent, and renegotiated loans, but not loans that have been written off.	USD
Number of active borrowers	Y4	The number of individuals who currently have an outstanding loan balance with the MFIs or are primarily responsible for repaying any portion of the gross loan portfolio.	Number

Source: Authors compilation from the MIX data.

trade-off might exist by utilizing recent data and robust econometric techniques. However, this study does not aim at determining the compatibility or trade-off relationship between the dual objectives of MFIs, but rather emphasizes the necessity of attaining both objectives hand-in-hand to create a long-term impact on the society. Hence, each of the stages was attributed an equal weightage to estimate efficiency in this study. To this end, Figure 2 depicts the network production process of MFIs and Table 1 provides the definitions of variables used in the efficiency analysis.

Table 2 provides the summary of descriptive statistics for all inputs, intermediates and outputs. It should be noted that the range (differences between minimum and maximum) for all variables are fairly large, indicating the differences in operating scales of the sampled MFIs. Given the large differences, Du et al. (2014) argued that the use of unit-invariants in efficiency analysis is justified.

The DEA analysis requires an 'isotonic' assumption, indicating a positive correlation of input and output variables (Golany & Roll, 1989). Hence, we have estimated correlation among the input and output variables and reported in Table 3. Our results revealed that all variables (between input and output) have significant positive correlations fulfilling the 'isotonic' assumption of using the DEA. As a result, the developed network framework for microfinance efficiency holds a high construct validity.

Table 2. Summary statistics of inputs, intermediates, and outputs.

Variable	Mean	Std. deviation	Range	Median	Observations
X1	1,680.11	3,299.87	26,234	605.00	540
X2	267,509,029.95	442,945,438.78	2,897,756,707	90,391,038.00	540
X3	25,439,111.44	60,398,885.11	586,651,947	9,286,543.00	540
Z1	145,610,368.58	273,972,458.12	1,800,993,262	35,581,349.50	540
Z2	50,529,265.89	137,392,090.67	1,564,332,109	14,461,305.00	540
Z3	51,837,644.63	110,903,900.30	981,293,408	17,510,415.50	540
Y1	8,429,774.24	27,492,496.03	302,714,684	1,748,271.00	540
Y2	46,685,069.09	108,552,531.07	965,644,687	15,384,951.00	540
Y3	210,645,860.52	350,060,648.23	1,958,674,552	68,460,750.50	540
Y4	227,211.46	685,064.85	6,794,191	54,989.00	540

Note: Please refer to Table 1 for definition of variables. Note: year wise summary statistics are available in Appendix A. Source: Authors.

3.3. Efficiency measurement—modelling

Radial network DEA models are subjective in reflecting the actual input/output conditions for each DMU, and assume that input/output variables change proportionally (Nourani et al., 2019). On the contrary, non-radial models provide reliable efficiency scores because efficiency is gauged from dealing with input excesses and output shortfalls, while no proportional changes are permitted (Nourani et al., 2018). Network SBM (Tone & Tsutsui, 2009)–a non-radial model, overcomes the shortcoming of radial models and is appropriate for evaluating the three-stage microfinance efficiency. This study deals with n microfinances ($j = 1, \ldots, n$) with k divisions ($k = 1, \ldots, n$) .m_k is the number of inputs and h_k is the number of outputs for stage k. With the assumption of free link activities, the non-oriented Network SBM problem is defined as:

$$\begin{gathered}
\rho_{ok} = MIN \sum_{k=1}^{K}\left[1-\frac{1}{m_k}\left(\sum_{i=1}^{m_k}\frac{S_i^{k^-}}{x_{io}^k}\right)\right] \Big/ \sum_{k=1}^{K}\left[1+\frac{1}{r_k}\left(\sum_{r=1}^{h_k}\frac{S_r^{k^+}}{y_{ro}^k}\right)\right] \\
S.T. \\
x_{io}^k = \sum_{j=1}^{n} x_{ij}^k \lambda_j^k + S_i^{k^-}, i = 1, \ldots, m_k, \\
y_{ro}^k = \sum_{j=1}^{n} x_{rj}^k \lambda_j^k + S_r^{k^+}, r = 1, \ldots, m_k, \\
\sum_{j=1}^{n} z_{dj}^{(f,g)} \lambda_j^t = \sum_{j=1}^{n} z_{dj}^{(f,g)} \lambda_j^f, d = 1, \ldots, D, \\
\sum_{j=1}^{n} \lambda_j^k = 1, \\
\lambda_j^k \geq 0, s_i^{k^-} \geq 0, s_r^{k^+} \geq 0, \forall k, \forall (f,g).
\end{gathered} \tag{1}$$

where x_{ij}^k denotes the input value i to DMU j at stage k; y_{rj}^k is the output value r to DMU j at stage k; $z_{dj}^{(f,g)}$ is the intermediate value d linking stage f to stage g for DMU j; D is the number of intermediate variables; $\sum_{j=1}^{n} \lambda_j^k = 1$ implies variable returns to scale (VRS) technology (Banker et al., 1984) at stage k. The VRS technology is appropriate, as it offsets the possible influence of different scales of inputs and outputs on the efficiency results (Lu et al., 2016). Utilizing the Charnes and Cooper transformation (Tone, 2001), the problem can then be solved by transforming into a linear program. If $\rho_o^* = 1$ in Equation (1), the DMU is deemed overall efficient. The efficiency score of the stage k for each DMU is defined as:

Table 3. Spearman's rho correlation coefficients (2013-2018).

	X1	X2	X3	Z1	Z2	Z3	Y1	Y2	Y3	Y4
X1	1									
X2	0.742**	1								
X3	0.836**	0.941**	1							
Z1	0.567**	0.924**	0.825**	1						
Z2	0.748**	0.951**	0.924**	0.847**	1					
Z3	0.746**	0.754**	0.760**	0.564**	0.712**	1				
Y1	0.761**	0.839**	0.803**	0.733**	0.873**	0.666**	1			
Y2	0.831**	0.958**	0.980**	0.847**	0.927**	0.791**	0.832**	1		
Y3	0.741**	0.987**	0.933**	0.907**	0.934**	0.773**	0.827**	0.968**	1	
Y4	0.909**	0.615**	0.689**	.441**	0.641**	0.674**	0.713**	0.701**	0.623**	1

Note: Please refer to Table 1 for definition of variables.
**Correlation is significant at the 0.01 level (two-tailed).
Source: Authors.

$$\rho_{ok} = \frac{1 - \frac{1}{m_k}\left(\sum_{i=1}^{m_k} \frac{S_i^{k-+}}{x_{io}^k}\right)}{1 + \frac{1}{r_k}\left(\sum_{r=1}^{h_k} \frac{S_r^{k++}}{y_{ro}^k}\right)}, (k = 1, \ldots, K) \tag{2}$$

where S_i^{k-*} is the optimal input slacks and S_r^{k+*} is the optimal output slacks. If ρ_{ok}^*=1, then the DMU is deemed technically efficient at stage k . If ρ_{ok}^* is smaller than one, then the DMU is technically inefficient.

4. Results and analysis

4.1. Efficiency analysis

Figure 3 expresses the yearly efficiency scores for MFIs, indicating the overall efficiency during the sample period as 0.3383 and denoting a 66.17% allowance for improvement. Operational efficiency was the largest amongst the three divisions, exceeding twice the value of each division. The low-efficiency scores of financial sustainability and social outreach of MFIs resulted in a low overall efficiency as well, with the MFIs showing a slightly better average financial sustainability (0.3644) than the social outreach (0.3506). The low overall efficiency of MFIs is confirmed in a number of previous studies (Fall et al., 2018). For example, Adusei (2019) discovered that the number of technically efficient MFIs remained below 10%, and that the overall technical efficiency of global MFIs was abysmal. As such, the results demonstrate the potential superiority of our efficiency framework over established approaches, where we discovered the reason for the low overall efficiency observed in microfinance literature, i.e. financial sustainability and social outreach divisions.

An observation of the overall trend of the efficiency scores for operational division indicated a slight increase over the years except in 2014 (Figure 4). Moreover, a slight fluctuation was also observed for the financial sustainability and social outreach divisions, particularly in the former division. That being said, it is also glaring that 2018 was not a promising year for MFIs owing to a relatively lower overall efficiency, which could be mainly attributed to the financial sustainability division. The general upward trend of efficiency scores is consistent with the microfinance literature. In a

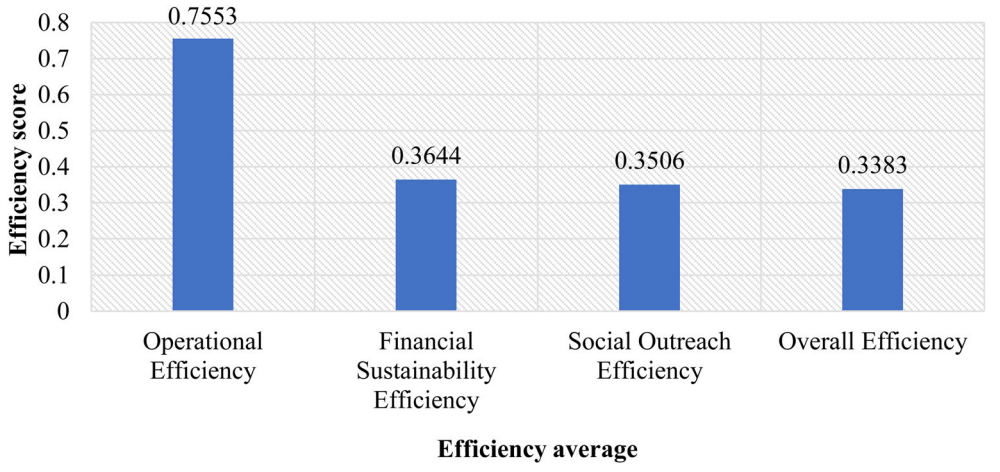

Figure 3. Average overall and divisional efficiencies of MFIs.
Source: Authors.

meta-analysis of 38 studies; Fall et al. (2018) highlighted that the mean efficiency scores of MFIs have increased over time.

Table 4 provides a clustery of the efficiency scores in three divisions and overall efficiency based on three attributes: regulatory status, region, and legal status. An MFI is either regulated or non-regulated, as indicated by a 'yes' or 'no', respectively. A total of six regions were selected for the categorization, based on the geographical locations of the country. 'Legal status' was grouped into five main categories and the additional classes were further classified. Starting with the regulatory status; regulated MFIs were discovered to be better off with operational efficiency, but with a poor performance in financial sustainability and social outreach efficiencies as compared to the non-regulated ones. As a result, the non-regulated firms ultimately score higher in overall efficiency.

Within the regulated category; 40 MFIs (240 observations) in Latin America and the Caribbean (LAC), and the Middle East and North Africa (MENA) achieved outstanding operational efficiency; contributing significantly to the operational efficiency of the whole sample. However, the MENA institutions were the first and second worst performers in financial sustainability and social outreach respectively. By observing individual regions and their respective legal statuses, more details about the inefficiency of MFIs were revealed. As an instance, the inefficiency of MFIs in Africa was caused by banks for operational and social outreach efficiencies, and by the NGOs for financial sustainability efficiency. In East Asia and the Pacific (EAP), rural MFIs performed poorly in areas of financial sustainability and social outreach efficiencies, but excellently in operational efficiency; this, however, did not help in the alleviation of the overall efficiency.

The non-regulated MFIs operate only in two regions—the EAP and LAC (based on our sample). Their low operational efficiency as compared to the regulated firms is attributed to the institutions in the LAC; although, the operational efficiency of the EAP is also not impressive. Due to the absence of regulation, many MFIs in the LAC and central Asian region are unable or have limited capacity to process public

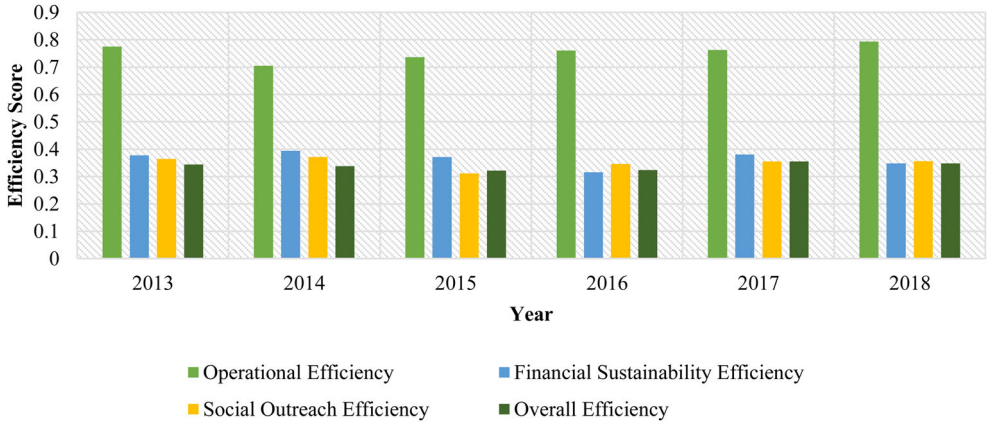

Figure 4. Trend of efficiency scores of MFIs (2013-2018).
Source: Authors.

deposits or attract shareholders for equity investment (Bogan, 2012). Regulation helps MFIs to generate funds from various sources and diversify their capital structure as long as the principle of microfinance is not violated (Hoque et al., 2011; Tchuigoua, 2014). Additionally; donors, equity investors and the public have confidence and prefer to invest in regulated MFIs, as regulation tends to protect the interest of investors (Pati, 2015). This is buttressed by Tchuigoua (2014), where regulated MFIs have a higher debt ratio and positive significant effect on deposit (but negative on borrowing). Thus, it is observed that the non-regulated MFIs have lower operational efficiency than the regulated one. Nonetheless, the non-regulated nonbank financial institutions (NBFI) in the EAP performed better in terms of social outreach efficiency as compared to their LAC counterpart (Table 4).

The efficiency trends of MFIs in Figures 5–7, is depicted based on regulatory status, region and legal status, respectively. The regulated MFIs, shown in narrow lines, performed better in all years in the sample with an upward trend for operational efficiency, but poorly in financial sustainability and social outreach efficiencies with downward trends. Our findings correspond with the argument of Hartarska and Nadolnyak (2007); Pati (2015) which indicates that regulation does not directly affect or have visible effects on the outreach or financial sustainability objectives of MFIs. Hartarska and Nadolnyak (2007) further claimed that the regulatory environment may divert the attention of MFIs from serving the poor to wealthier clients which will have negative consequences on innovative development. Moreover, Pati (2015) also discovered that the unregulated MFIs have very high growth in different outreach indicators. Hence lower performance in both dimensions is observed for regulated but not for unregulated MFIs in this study.

This highlights that the regulated institutions must take their financial sustainability and social outreach into account in their policy decisions. In fact, it is interesting to observe the extent to which the social outreach efficiency of non-regulated MFIs is better than the regulated ones. However, while the performance of non-regulated MFIs is much better in financial sustainability and social outreach efficiencies

Table 4. Clustering average efficiencies based on regulatory status, legal status, and region.

Regulated	Region	Legal status	Div1	Div2	Div3	Overall	N
Yes	All	All	0.7731	0.3557	0.3247	0.3275	492
No	All	All	0.5727	0.4525	0.6158	0.4491	48
Yes	Africa	All	0.5623	0.5098	0.2963	0.3043	24
Yes	Africa	Bank	0.5237	0.6042	0.1919	0.2807	18
Yes	Africa	NGO	0.6783	0.2267	0.6094	0.3749	6
Yes	EAP	All	0.7521	0.3834	0.2833	0.3436	72
Yes	EAP	NBFI	0.7820	0.4106	0.3333	0.3904	48
Yes	EAP	NGO	0.5874	0.5532	0.1860	0.3141	6
Yes	EAP	Other	0.6426	0.3480	0.3932	0.3997	6
Yes	EAP	Rural	0.7697	0.2072	0.0770	0.1431	12
Yes	EUCA	All	0.6911	0.3419	0.1701	0.2221	36
Yes	EUCA	Bank	0.7420	0.4512	0.1866	0.2516	18
Yes	EUCA	CU/C	0.7427	0.1211	0.0534	0.0895	6
Yes	EUCA	NBFI	0.5889	0.2884	0.2036	0.2441	12
Yes	LAC	All	0.8451	0.3398	0.2179	0.2755	234
Yes	LAC	Bank	0.8446	0.4176	0.3184	0.3758	102
Yes	LAC	CU/C	0.8814	0.2531	0.1231	0.1806	114
Yes	LAC	NBFI	0.6177	0.4475	0.2494	0.3085	18
Yes	MENA	Bank	0.8960	0.1011	0.1111	0.1175	6
Yes	South Asia	All	0.7061	0.3563	0.6204	0.4660	120
Yes	South Asia	Bank	0.7404	0.2634	0.3801	0.3514	30
Yes	South Asia	CU/C	0.7409	0.2378	0.6450	0.4034	6
Yes	South Asia	NGO	0.6913	0.3979	0.7045	0.5114	84
No	EAP	All	0.5862	0.4512	0.6602	0.4597	42
No	EAP	NBFI	0.5441	0.3954	0.8517	0.4344	6
No	EAP	NGO	0.5577	0.5105	0.6545	0.4890	30
No	EAP	Other	0.7710	0.2106	0.4974	0.3385	6
No	LAC	NBFI	0.4782	0.4615	0.3049	0.3752	6

Note: EAP is East Asia and the Pacific; EUCA is Eastern Europe and Central Asia; LAC is Latin America and the Caribbean; MENA is Middle East and North Africa; Rural is Rural Bank; CU/C is Credit. Union/Cooperative; NBFI is non-bank financial institution; NGO is nongovernment organization. Div1 is Operational Efficiency; Div2 is Financial Sustainability Efficiency; Div3 is Social Outreach Efficiency; Overall is Overall Efficiency.

compared to the regulated ones; the trends are not promising, particularly for the year 2018.

Figure 6 unveils the periodic efficiencies of MFIs in different regions. The operational efficiency line of MENA had the highest picks among other regions with a large fluctuation, while Africa remained in the lowest rank throughout the sample period. This finding is in the reverse in terms of financial sustainability, noting that MFIs in MENA almost dropped to zero efficiencies in the year 2017 and 2018. MENA continued similar pattern in social outreach division, while South Asia performed best among other regions. The good performance of South Asia in the social outreach resulted in it coming first amongst other regions in terms of overall efficiency. Our findings are somewhat relevant to the arguments of Vanroose and D'Espallier (2013), where the duo claimed that countries with lower financial sector development will have better financial and outreach performance of MFIs. Since the South Asian region remains one of the poorly developed regions particularly in financial sector development (Sahoo & Dash, 2013), it becomes a positive factor for better efficiency results of MFIs. However, this does not indicate the absence of other countries or region with lower financial sector development than South Asia. On the overall, our findings also correspond with other studies that indicate that location does matter in explaining the variations in efficiency of MFIs (Gutiérrez-Nieto et al., 2009).

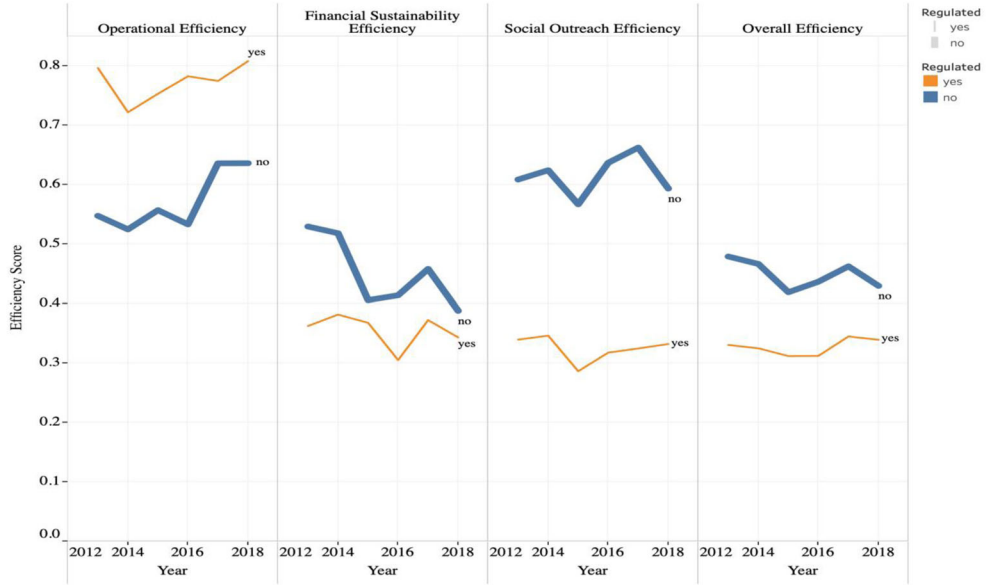

Figure 5. The yearly trends of average efficiency scores broken down by regulatory status.
Note: Regulatory status is shown by size and/or color.
Source: Authors.

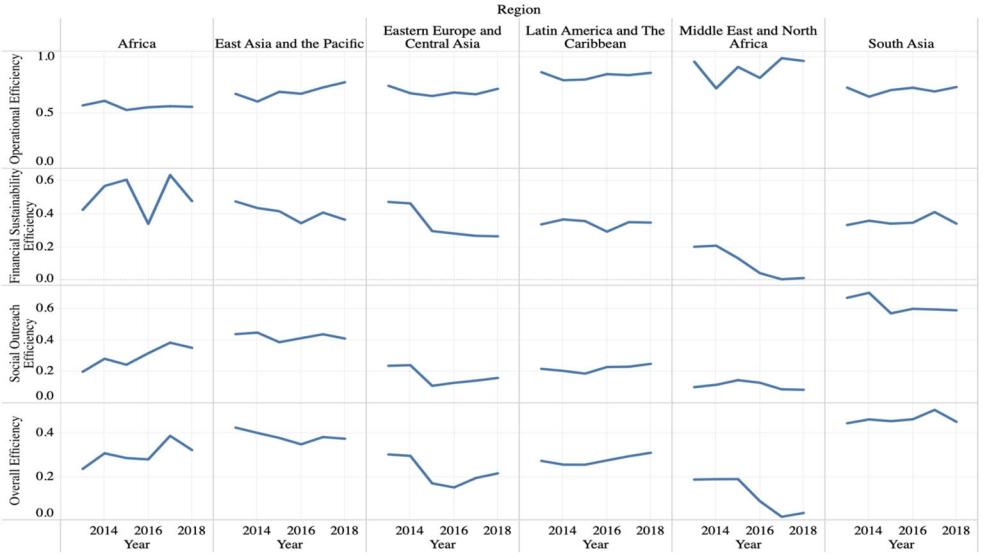

Figure 6. The yearly trends of average efficiency scores broken down by region.
Source: Authors.

Figure 7 broke down the efficiency scores by microfinance legal status. Interestingly, all MFIs performed comparably in operational efficiency, with the Credit Union/Cooperative (CU/C) performing slightly better with a nearly flat trend than others. The NBFI and rural banks had a notable improvement in their operational efficiency in 2018. Substantial differences were observed in the financial sustainability and social outreach efficiencies between MFIs with various legal status.

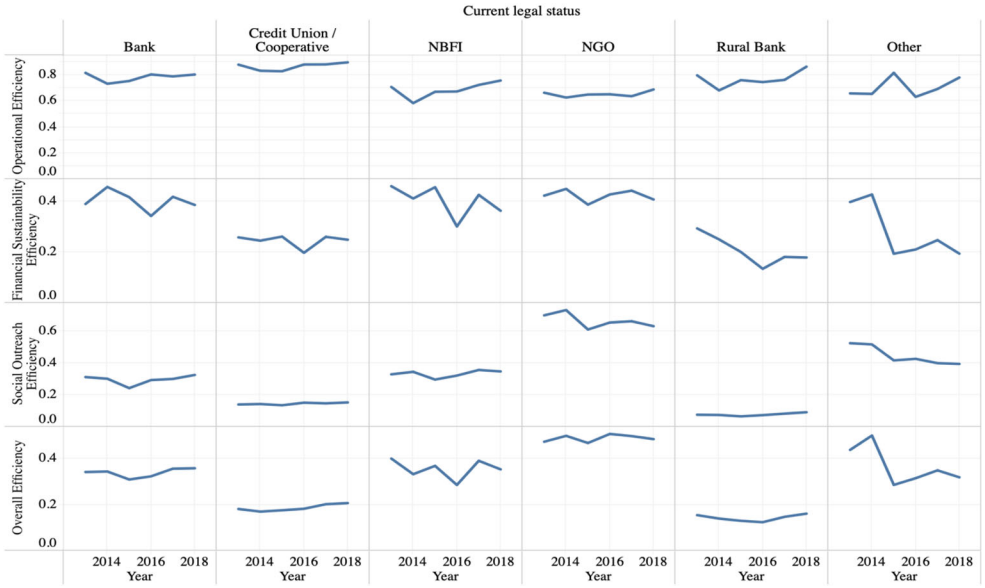

Figure 7. The yearly trends of average efficiency scores broken down by legal status.
Source: Authors.

Rural banks were among the poorest in these two divisions, with the poor performance more pronounced in social outreach efficiency. Similarly, the CU/C did not perform well in social outreach division. Comparatively, the NGOs showed an above average performance amongst other types of MFIs; which is at par with the arguments of Vanroose and D'Espallier (2013), and social ethos compared with other legal status (Gutiérrez-Nieto et al., 2009).

4.2. Potential improvement in efficiency through frontier projection

The un-tabulated results indicated that a measly three of ninety MFIs achieved an efficiency of unity for the three divisions[2]. An approximate 97% of the MFIs were inefficient, which is quite alarming especially in the context where attaining efficiency remains an important dimension of MFIs survival in the long run. As previously highlighted, there is at least, a 66.17% room for improvement. In a bid to exploring the shortage or excess of resources a relatively inefficient MFI is required to improve on, we provide the average frontier projections of the inputs, intermediates and outputs in Table 5. The values are in percentage; with a positive value indicating that an output or intermediate should be increased, and a negative value suggesting otherwise. In particular, the frontier projection analysis aims to identify the marginal contribution of a decrease/increase in input/output to changes in the efficiency scores.

As depicted in Table 5, inefficient MFIs must reduce their number of employees by 39.62% on average. Total assets, on the other hand, are almost sufficiently utilized. As for the third input, the operating expense has to be cut down by 30.72% on average. In order to improve their efficiency scores, MFIs have to substantially increase

Table 5. Average potential improvements (%).

	X1	X2	X3	Z1	Z2	Z3	Y1	Y2	Y3	Y4
2013	−43.02	−2.24	−22.33	50.78	43.74	261.83	443.69	138.32	26.90	1630.16
2014	−43.68	−2.48	−42.42	40.94	52.66	402.80	449.98	148.03	22.10	1729.48
2015	−42.77	−3.17	−33.26	100.06	47.44	158.82	270.16	218.33	31.37	1841.52
2016	−37.04	−4.41	−30.32	76.20	73.65	170.76	997.05	202.06	25.74	1376.19
2017	−36.25	−3.73	−31.23	61.76	62.46	185.15	391.84	538.15	30.54	1340.53
2018	−34.95	−2.36	−24.77	28.83	88.39	165.82	592.08	278.70	29.18	1240.45
Average	−39.62	−3.07	−30.72	59.76	61.39	224.20	524.13	253.93	27.64	1526.39

Note: Please refer to Table 1 for definition of variables. Negative values: excess of resources, positive values: shortage of resources. The large percentage values of Y1 (Net Income) and Y4 (Number of Active Borrowers) indicate the severe shortage of these two outputs in achieving financial sustainability and social outreach efficiency respectively. For example, in the year 2018, MFIs were required to increase their net income by nearly 6 folds and their number of active borrowers by over 12 folds to achieve financial sustainability and social outreach efficiency respectively; in addition to a decrease and increase in other inputs, intermediates and outputs.
Source: Authors.

their borrowings to improve their final output quantities. In particular, MFIs are experiencing underproduction of output values in financial sustainability and social outreach divisions. Hence, better usage of input quantities and the generation of more intermediates will result in better financial and outreach performance. While it may be impossible to implement the suggested policies overnight, MFIs should take gradual approaches to ensure their viability in the long run for the cause of social progress.

5. Conclusion

MFIs are the key financing channel for the unbanked population, contingent upon their smooth operation with maintaining an acceptable level of efficiency. However, the accurate measure of efficiency is quite questionable, considering the trade-off existent between the dual objectives of MFIs—social outreach and financial sustainability. Hence, this study employs a NDEA to evaluate efficiency of MFIs. Our proposed performance framework utilized the notion of dual objectives of MFIs in generating the final outputs. As such, the black-box production process of MFIs was broken into three divisions, operational, financial sustainability, and social outreach efficiencies. To measure the efficiency, we utilized data of 90 MFIs globally between 2013 and 2018. The efficiency analysis revealed that MFIs were confronted with severe inefficiency which is as a result of financial sustainability and social outreach divisions; the two main pillars of microfinance operation.

However, MFIs are performing better in the transformation of the inputs to intermediates; which are required for the operation of subsequent divisions. Further analysis revealed that the overall and divisional performance of MFIs substantially differs in various regions, legal status and regulatory environment. Our projection analysis highlighted that the inefficiencies of MFIs are mainly due to the excess level of input values, namely, the number of personnel and operating expenses, and shortage of intermediate and output values; particularly, total borrowing, net income, gross loan portfolio, and the number of active borrowers. Based on this discovery, we can translate that there is need for MFIs to undertake necessary initiatives and reduce their wastage of resources particularly in the number of employees and operational

expenses. One of the ways to reduce operational expenses would be by incorporating recent and latest technologies in operation processes (e.g. mobile banking/computerized operating system, etc.), so that physical labor and delivery/operating costs can be minimized. As the results also suggest an increase in output under social outreach division; innovating market-based financial products and integrating non-financial products could help MFIs bolster their clients base. It may be initially costly for MFIs to adopt new technologies and innovations; however, a drastic reduction in the overall costs will be achieved on the long run.

The findings of the study also raise concerns over the microfinance models operated under the intermediary approach. While these MFIs may perform well in generating financial resources from the market, they are highly unlikely to have better social outreach and financial sustainability efficiencies as depicted in the results. Hence, the regulatory authorities of the respective countries should enforce thorough judgement when granting licenses to MFIs aiming to operate under the intermediation approach. By saying this, we do not mean to curb the licensing of MFIs, but recommend a proper vetting before granting licenses to ensure the original aim of microfinance programs is not compromised.

6. Limitations and guidance for future research

While the study has unraveled an important dimension of microfinance efficiency via utilization of a unique production process and recent data, it is not devoid of limitation. Since unregulated MFIs have relatively excelled in social outreach and financial sustainability efficiencies than their counterparts, further investigation is required to identify the mechanisms of such outcome. Having said that, the sample size used in this study is also not equal for regulated and non-regulated types of MFIs; hence, the differences in the number of DMUs may also partly contribute to the differences in efficiency results between the two groups. A similar view also holds for legal status and regional comparison of the efficiency results. Thus, the findings should be interpreted with caution, and a thorough empirical (e.g. parametric) analysis is needed before making a conclusive remark in this aspect.

Moreover, as our analysis has dealt with different countries based on the availability of the data where microfinance remains an important policy instrument, more advanced methodologies could be integrated (e.g. meta frontier DEA technique) in future studies. Apart from that, the effects of institutional and macroeconomic factors on various dimensions of efficiency of MFIs could also be explored. Moreover, as Islamic microfinance has been rapidly growing across countries, a comparative analysis of efficiency between conventional and Islamic MFIs could also unravel interesting research findings. While these limitations do not affect the overall findings and conclusion of the study; they, however, provide an opportunity to be discovered in future studies.

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Notes

1. https://datacatalog.worldbank.org/dataset/mix-market
2. For brevity, the efficiency scores and potential improvements of individual MFIs are not displayed and will be available upon request.

Disclosure statement

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Appendix A: Yearly descriptive statistics of inputs, intermediates, and outputs

Year		X1	X2	X3	Z1	Z2	Z3	Y1	Y2	Y3	Y4
2013	Mean	1,382.22	189,092,336.69	21,567,835.02	93,849,083.82	36,561,895.07	45,896,543.51	6,843,488.79	37,010,259.42	147,072,156.51	191,913.38
	SD	2,853.02	306,332,492.21	52,991,816.67	174,274,084.24	94,497,909.69	108,008,504.87	23,712,825.72	99,275,665.19	241,891,728.82	543,238.50
	Median	504.50	65,051,627.00	7,434,558.50	20,857,885.00	12,107,713.50	17,440,750.00	1,076,573.50	12,802,109.50	48,120,933.50	52,332.50
2014	Mean	1,508.41	220,854,875.76	23,244,890.37	112,665,476.44	43,337,658.18	49,270,681.67	8,216,916.74	40,921,326.49	174,417,264.93	208,756.18
	SD	3,048.63	352,216,081.90	58,218,174.06	200,093,116.81	112,646,395.65	112,166,038.74	29,203,680.36	107,648,797.62	281,315,236.44	629,892.46
	Median	577.00	83,360,868.50	9,014,872.00	25,899,981.50	13,684,420.50	16,781,573.00	1,522,119.00	14,317,898.50	58,064,165.00	52,562.50
2015	Mean	1,662.68	243,316,901.34	25,444,488.63	127,667,556.90	47,046,151.03	53,131,937.70	8,187,968.76	46,034,395.88	194,847,929.51	232,119.81
	SD	3,336.01	392,804,012.47	63,636,309.26	242,648,502.64	135,535,894.29	119,275,121.72	26,303,184.87	111,395,799.96	317,065,185.04	724,591.42
	Median	606.00	88,422,962.00	9,331,537.50	28,487,376.50	14,659,860.50	18,456,671.00	1,866,471.00	14,516,384.00	65,247,669.00	54,432.00
2016	Mean	1,745.01	278,145,122.36	25,428,875.06	154,435,539.32	51,015,624.76	52,563,873.00	7,933,256.58	48,128,867.60	218,314,331.57	244,714.23
	SD	3,420.40	449,849,018.23	58,167,217.73	286,751,418.45	134,867,235.10	106,954,932.84	28,403,854.12	110,036,456.16	361,616,296.91	785,306.39
	Median	623.00	99,097,126.00	9,356,847.00	40,103,091.00	15,261,128.50	17,386,979.00	1,695,596.00	14,836,677.50	75,555,362.50	56,134.50
2017	Mean	1,847.16	316,590,454.81	27,389,114.56	181,495,849.28	59,024,947.21	51,858,575.28	9,374,547.53	52,544,406.04	248,823,866.46	239,948.72
	SD	3,536.90	508,175,229.43	63,073,504.60	324,340,181.99	156,015,135.71	97,170,947.70	30,013,237.33	114,195,275.93	402,013,796.05	715,424.58
	Median	666.00	106,809,288.00	10,652,422.00	51,061,754.50	17,516,838.00	17,756,346.00	2,208,582.50	17,651,460.50	81,487,241.50	57,740.50
2018	Mean	1,935.19	357,054,488.74	29,559,464.99	203,548,705.69	66,189,319.09	58,304,256.64	10,022,467.02	55,471,159.10	280,399,614.14	245,816.42
	SD	3,599.53	579,447,507.99	66,658,078.11	359,116,127.72	176,686,152.43	122,666,252.46	27,505,204.12	110,085,523.80	446,606,300.97	703,102.14
	Median	731.00	129,021,045.00	11,490,923.00	58,455,267.00	19,744,606.00	18,071,193.50	2,070,536.00	19,283,311.50	100,408,022.50	62,533.50

Source: Authors estimate based on MIX data. For full name and description of the variables, kindly see Table 1.