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Observing choice of loan methods in not-for-profit microfinance using data envelopment analysis

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ABSTRACT

Distributing loan using group lending method is one of the unique features in microfinance, as it utilises peer monitoring and dynamic incentive to lower credit risks in extending collateral-free loan to the poor. However, many microfinance institutions (MFIs) eventually perceive it to be costly and restricting loan growth thereby resorted to individual lending method to enhance profitability. On the other hand, village banking method was developed to boost outreach and to create self-sustaining village microbanks. We thus seek to empirically observe the loan method – efficiency relationship and to examine the best loan method regionally; focusing on not-for-profit MFIs that are widely regarded as best microfinance provider. Non-oriented Data Envelopment Analysis with regional meta-frontier approach is used for efficiency assessment of 628 MFIs from 87 countries in 6 regions, followed by Tobit regression. We also investigated factors affecting efficiencies such as borrowings, total donation, cost per borrower (CPB), portfolio at risk (PAR), interest rates, MFI age, regulation status, and legal format. The results support our argument that appropriate performance analysis should best be performed on regional basis separately as we find different results for different region.

1. Introduction

Over the last few decades, microfinance has provided financial access to the poor households who would otherwise be left out of by traditional financial infrastructures. Whilst most of these 'unbankables' (Simanowitz & Walter, 2002) demand small loans which are infeasible for mainstream banking industry to serve given the transaction costs incurred (Armendariz de Aghion & Morduch, 2005), financial access is still denied to the rest albeit having collateral (Johnston & Morduch, 2008). Microfinance bridges this gap by opening financial access thereto, generating well-recorded contribution in poverty alleviation e.g. poverty reduction from 60% in 1970 to 11.5% in 1996 in Indonesia (Seibel & Agung, 2006), small businesses spur in many countries e.g. Argentina, Philippine, Kenya and Senegal (Robinson, 2001), households reconstruction in war-torn countries like Bosnia-Herzegovina (Matul & Tsilikounas, 2004) and in disaster-torn countries e.g. Sri Lanka (Becchetti & Castriota, 2011).

As poverty eradication instrument (van Rooyen, Stewart, & de Wet, 2012), MFIs face dual objectives of reaching out to the poorest whilst striving for long term sustenance as viable financial institution, i.e. a dual bottom line of outreach and financial sustainability (Marr, 2003). A trade-off is observed herein whereby outreach is attained at the expense of financial sustainability, e.g. in Hermes and Lensink (2007b), Hermes, Lensink, and Meesters (2011), Olivares-polanco (2005) and Schreiner (2002), prompting two approaches with different focus in microfinance: institutionalist approach on sustainability and welfarist approach on outreach (Robinson, 2001). Alternatively, Simanowitz (2007) suggested a middle way where trade-off can and should be managed. Perceiving dual objectives as relative measures, Widiarto and Emrouznejad (2015) thus observed using non-parametric data envelopment analysis (DEA) that these objectives can be pursued concurrently by best-practice MFIs in a region/frontier exercising appropriate strategy. Likewise, Miyashita (2000) and Cull, Demirguc-Kunt, and Morduch (2007) stress on the importance of MFI strategy formulation and credit design to manage this trade-off.

One central strategy is an appropriate lending methodology. The reluctance of mainstream financial institutions to finance the poor is due to *ex ante* adverse selection and *ex post* moral hazard (Hermes & Lensink, 2007a). Grameen Bank Bangladesh thus pioneered an innovative group lending scheme that mitigates these risks through joint liability; borrowers voluntarily form a small group whose members are jointly liable for each other's loan and are barred from future loans in the case of non-repayment

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(Ghatak & Guinnane, 1999), termed as dynamic incentives (Kono & Takahashi, 2010). A mutual and morally binding guarantee in lieu of collateral exists herein via a peer guarantee mechanism; members motivate and monitor each other whilst implant social sanctions to non-compliant ones (Varian, 1990), mitigating information asymmetry thus avoiding adverse selection and moral hazard problem (Godquin, 2004). Members thus have incentive to voluntarily assist potential defaulter in loan repayment (Abdul Rahman, 2007). The theoretical advantages of group lending has been discussed in depth, e.g. Armendariz de Aghion and Morduch (2005), Gomez and Santor (2001), Stiglitz (1990) and Ghatak (2000). Grameen Bank had proven the effectiveness of this method by having 98% repayment rate hence replicated globally (Anthony, 2005).

However, group lending may arguably induce agency problem that ironically omit the poorest from microcredit access, i.e. excluded in group formation as deemed risky (Marr, 2003) or rejected by MFI loan officer to avoid delinquency (Hulme & Mosley, 1996). Moreover, group meetings and trainings trigger higher costs that increases interest rates (Shankar, 2007) and group mechanism may limit borrowers with growing business (Madajewicz, 2011). Whilst group repayment is theoretically enhanced by exploiting local information (Ghatak, 2000), empirical evidences suggest that repayment is enhanced only if social homogeneity and personal trust exist between members (Cassar, Crowley, & Wydick, 2007; Karlan, 2007).

Conversely, Indonesia's BRI Unit Desa, the biggest MFI in the world, takes more commercial approach and employs individual lending akin to mainstream financial institutions (Helms, 2006), i.e. a bilateral loan agreement between an MFI and sole borrower based on her creditworthiness that is usually collateral-based (Dellien, Burnett, Gincherman, & Lynch, 2005). However, the risks herein are not assessed from document scrutiny; instead, ranging from visit to applicants' businesses and homes to loan guarantee and character reference from local village committee (Armendáriz de Aghion & Morduch, 2000; Churchill, 1999). Moreover, guarantor exercises social pressure for timely repayment (Jaunaux & Venet, 2009). Dynamic incentives is also implemented herein to mitigate ex post moral hazard and strategic default, i.e. borrowing without intention to repay the loan (Hermes & Lensink, 2007a; Kono & Takahashi, 2010). Individual lending indeed exhibits lower transaction costs with loan structure flexibility sans peer guarantee (Westley, 2004) that accommodates borrowers with growing businesses (Madajewicz, 2011), especially in relatively industrialized area and in transition economies (Armendáriz de Aghion & Morduch, 2000). Many group MFIs also offer individual loan to prevent progressing clients from moving to competitors and to attract new clients (Dellien et al., 2005), including pioneers e.g. Grameen Bank Bangladesh (Hermes & Lensink, 2007a). Some even shifted completely into individual lending, e.g. BancoSol Bolivia (Cull et al., 2007). Many Latin American non-bank financial institutions and banks employ this method (Servin, Lensink, & van den Berg, 2012), as well as MFIs in East Asia (Cull et al., 2007), Middle East (Abdelkader, Jemaa, & Mekki, 2012), and Eastern Europe (Armendáriz de Aghion & Morduch, 2000).

Nevertheless, attracting better-off clients with individual lending is often done at the expense of the poorest, i.e. mission drift (Armendariz & Szafarz, 2011; Cull et al., 2007). Individual lending tends to have lower outreach as collateral requirements deters poorest borrowers (Cull et al., 2007; Hermes et al., 2011). Comparison between group and individual lending are discussed comprehensively in Dellien et al. (2005), Lehner (2009), Madajewicz (2011), and Giné and Karlan (2014).

Separately, The Foundation for International Community Assistance (FINCA International) in Latin America pioneered village banking scheme: facilitating access to credits and savings through community-managed associations established at village level with 30–50 members – hence 'village bank' (Westley, 2004). It is typically facilitated by non-governmental organizations (NGOs) in channelling external capital from local commercial banks for subsequent financing to village bank members, which is tied to member's deposit (Morduch, 1999). Akin to group lending, peer pressure mechanism is herein implemented to ensure timely loan repayment to sponsors warranting continuous capital injections, whilst it contrarily adopts bylaws, elects president and treasurer, and manages its members' loans and savings independently. It preserves internal accounts from savings and time gap in interest and principal payment to its sponsors that can further be extended as extra loans (Westley, 2004). Its ultimate goal is internal capital accumulation to eventually graduate as an autonomous self-sustaining financial provider in three years (Morduch, 1999; Obaidullah, 2008). Village banking has been replicated mainly in Latin America and Africa (Obaidullah, 2008) where it contributed significantly to poverty alleviation effort in Latin America (Hiatt & Woodworth, 2006). It exhibits greater rural focus and lower average loan balance than other schemes (Westley, 2004).

Nevertheless, its transaction costs is higher due to self-management and compulsory attendance at meetings, thus its real benefit for borrowers lies in savings and non-financial services instead of being an efficient credit facilitators; inflexible loan structure and forced saving requirement are also often problematic to growing clients (Westley, 2004). Furthermore, its target to become independent in three year time is often delayed due to slow savings and growing credit demands (Morduch, 1999).

Therefore, as all methods are not without setback, which one is relatively best to pursue dual objectives? Furthermore, is there a method that performs best in all regions? Empirical evidence is thereby indispensable considering that different regions face different demographics and, from institutional theory perspective, MFIs must adapt to the rules and belief systems in their environment to survive (Scott, 1995). We argue that differences in demographics may affect appropriate loan method, i.e. concept of best loan method is thereby relative rather than absolute. Consequently, separate assessment of best method in different regions is more appropriate than a global one.

This paper therefore seeks to observe loan method - performance relationship. It firstly assesses MFIs' efficiency as measure of relative performance toward benchmark MFIs in overall performance, financial sustainability and outreach in six regions, namely Africa, East Asia and The Pacific (EAP), Eastern Europe and Central Asia (EECA), Latin America and The Caribbean (LAC), Middle East and North Africa (MENA), and South Asia (SA) separately, thereafter examines their relationship to loan methods. Research questions explored are: (1) whether loan methods have different impact to MFIs' efficiency in different regions; (2) whether a method and/or combination offering relatively higher overall, financial, and social efficiency in all regions exist. Herewith, the focus will be on not-for-profit MFIs as it is regarded by many as best microfinance provider, e.g. Dichter (1996) and Haq, Skully, and Pathan (2010); though extended to those beyond NGOs, i.e. credit union/ cooperatives, non-bank financial institutions (NBFI), etc. We previously observed that not-for-profit MFIs showed generally higher efficiency in EAP, MENA and SA regions (Widiarto & Emrouznejad, 2015).

We propose a non-parametric method of Data Envelopment Analysis (DEA) to measure relative performance vis-à-vis social, financial, and overall efficiency of MFI, specifically a non-oriented DEA meta-frontier approach. The contribution are therefore three folds, i.e. (1) contributing regional-based evidence to microfinance and DEA literatures regarding social and financial efficiency and their relationship with loan methods; (2) contributing to literatures in the use of non-oriented DEA in microfinance performance assessment, which have not been utilised thus far; (3) constructing basis for policy recommendation to MFIs in different regions.

The rest of the paper are organised as follow: Section 2 briefly reviews efficiency concept in microfinance context, Section 3 outlines DEA concept, model and specifications used with second stage Tobit regression model. The dataset is explained in Section 4, followed by first and second stage results in Sections 5 and 6, respectively, with conclusion and future research direction in Section 7.

2. Microfinance performance measurement and efficiency

2.1. Traditional financial ratio

The most common methodology that has hitherto been used in MFI performance measurement is traditional financial ratios or indicators, akin to that used in the mainstream financial institutions studies. Several sets of financial indicators had been prescribed by groups of multilateral banks, microfinance rating agencies, donors, and voluntary organisations to measure MFI performance (CGAP, 2003; Jansson, von Stauffenberg, Kenyon, & Barluenga-Badiola, 2003) and have been used in studies e.g. in Bhatt and Tang (2001), Churchill (1999), Khalily (2004), Koveos and Randhawa (2004), and Nanayakkara and Iselin (2012). The exhaustive list of all indicators prescribed by CGAP can be observed in Gutiérrez-Nieto, Serrano-Cinca, and Mar Molinero (2007).

However, as Balkenhol (2007), Gutiérrez-Nieto et al. (2007), and Fluckiger and Vassiliev (2007), we argue that financial ratios are not competent at capturing microfinance performance dynamics comprehensively as its social mission differentiates it from mainstream financial institution. Parallel with Bogetoft and Otto (2011), using financial ratios is also ambiguous due to partiality problem, i.e. an MFI can excel in one ratio but fail in others hence the difficulty in overall benchmarking. Assessing MFIs which focus more on social outreach, such as development/relief NGO, with the same yardstick with for-profit bank-MFI which has more focus on financial performance is not appropriate. Similarly, using outreach indicators as per Rosenberg (2009) as sole benchmark for MFI performance would pose the same problem for more commercially-focused MFIs. These two objectives cannot be interpreted separately as many MFIs combine them differently in their strategy. These indicators may lead to difficulty in objective evaluation if different indicators representing different MFI objectives sent different messages regarding MFI performance.

Moreover, MFI sustainability is not always narrowly defined as profitability for many MFIs; rather, as an ability to sustain long term operation (Nanayakkara, 2012). Some MFIs achieve sustainability by reaching profitability (e.g. for-profit MFIs such as banks or rural banks); yet there exist other MFIs, e.g. non-governmental organisation-based MFI (NGO-MFI), where profitability is not a major focus thus achieving sustainability by contribution from donors or external grants. The latter includes development NGOs providing microfinance services as ways to assist the impoverished communities in disaster and war-torn areas.

2.2. Microfinance and efficiency

Parallel with Balkenhol (2007), Gutiérrez-Nieto et al. (2007), Haq et al. (2010), Hassan and Sanchez (2009), and Widiarto and Emrouznejad (2015), we alternatively propose efficiency as measurement of MFI performance; more specifically, relative efficiency as per Farrell (1957), i.e. the assessment of actual resources utilisation by an organisation in producing a given quality of outputs relative to optimal use of these resources. Given contextual irrelevancy of input price, the focus herein will be on technical efficiency (TE), i.e. utilisation of inputs to produce outputs relative to best practice organisations with similar characteristics (Emrouznejad & Anouze, 2010), which is influenced by managerial practice and operational scale (Thanassoulis, 2001). We hereby refrain from using efficiency ratios as in MicroBanking Bulletin 2006 (Balkenhol, 2007) due to said partiality problems with ratios; rather, we utilise modern efficiency approach suitable for multiple-inputs and multiple-outputs environment so as to cover both distinct aspects of microfinance whilst applicable to both for-profit and not-for-profit MFIs. One such method is Data Envelopment Analysis.

2.3. Data envelopment analysis

Data envelopment analysis (DEA) is a non-parametric efficiency assessment method developed by Charnes, Cooper, and Rhodes (1978), expanding single input-output productive efficiency concept from Farrell (1957) into efficiency assessment of decision-making unit (DMU) involving multiple inputs-outputs. DEA utilises linear programming to construct a piecewise linear production frontier enveloping all data as reference set or benchmark against which each DMU is assessed (Cook & Zhu, 2005; Emrouznejad & Anouze, 2010). TE in DEA is measured as distance of a DMU to its benchmark(s) on the production frontier, thus creating relative efficiency measure for all DMUs (Emrouznejad & Anouze, 2009; Thanassoulis, 2001). From two basic models stated in Charnes et al. (1978) and Banker, Charnes, and Cooper (1984), DEA has since evolved greatly in its models and applications (see Emrouznejad, Parker, & Tavares, 2008). Recent developments includes hybrid models incorporating DEA with data mining, e.g. Emrouznejad and Shale (2009), Samoilenko and Osei-Bryson (2010) and Samoilenko and Osei-Bryson (2014).

Contrasting with parametric efficiency assessment, DEA evaluates efficiency without *a priori* assumption on the distribution and production function (Cook & Zhu, 2005; Cooper, Seiford, & Zhu, 2004) therefore applicable where multiple input-output relationship is not directly observable as in the context of microfinance. Several DEA-microfinance studies are listed in Appendix A. Relating to Gutiérrez-Nieto, Serrano-Cinca, and Mar Molinero (2009), we argue that microfinance dual objectives can be regarded as a problem of social efficiency and financial efficiency, i.e. how MFIs transform resources (inputs) to produce outputs related to outreach and sustainability objectives respectively, in comparison to their best performing peers.

2.4. DEA approaches

There are two main approaches in financial institution evaluation, i.e. production and intermediation approach which differ in the role of deposit, i.e. regarded as output in the former or as input in the latter (Athanassopoulos, 1997; Fethi & Pasiouras, 2010). Since many MFIs in our dataset are not collecting deposit hence production approach is used to maintain homogeneity, as per Fluckiger and Vassiliev (2007), Gutiérrez-Nieto et al. (2007), Gutiérrez-Nieto et al. (2009), Widiarto and Emrouznejad (2015) and Haq et al. (2010).

3. Methodology

3.1. DEA model – first stage analysis

The basic DEA models are based upon output- and input-orientated strategy. The former assesses maximum possible radial output expansion with constant input, whilst the latter measures maximum radial input reduction by maintaining constant output. These are manifest in DEA-microfinance studies highlighted in Appendix A. Yet, we argue that forcing all MFIs to be uniformly evaluated in either orientation is not realistic due to different MFI

conditions, e.g. output-orientated strategy may not be possible for MFIs in isolated area whilst input-orientated strategy may not suitable for MFIs already in inputs shortage. In addition to this, an MFI may not be able to just increase its output, e.g. its customer base (as one proxy for the width of outreach), to boost efficiency without simultaneously reducing its input, e.g. operational expenses.

Thus, we instead employ herein a hyperbolic non-oriented DEA that allows for simultaneous scaling of inputs and outputs as per Färe, Grosskopf, and Lovell (1994). This model allows for concurrent and equiproportionate reduction of inputs and expansion of outputs (Lewis, Mallikarjun, & Sexton, 2013). It has been used in banking sector, e.g. by Holod and Lewis (2011), and in other sector such as transportation (Mallikarjun, 2015; Mallikarjun, Lewis, & Sexton, 2014). As far as we concern, it has not been used in microfinance context hence our contribution. A more advance non-oriented, non-radial DEA model is used in Avkiran (2009) in banking sector.

Furthermore, we argue that MFI analysis based on constant return scale (CRS) is unrealistic as not all MFIs operate at their most productive scale size (MPSS). MFI size may hold a crucial factor in MFI efficiency, i.e. comparing small-sized MFIs with large-sized MFIs will therefore be inappropriate. As per Mallikarjun (2015), MFI inputs, e.g. operational expense, assets, and employees, increases as its size increases, but some of its outputs may increase at a decreasing rate, e.g. interest revenue. Variable return to scale (VRS) is thus more appropriate since MFIs are allowed to demonstrate different returns to scale due to different environment.

Based on our presumption on regional differences, efficiency is assessed in six regional frontiers separately for homogeneity and to obtain regional efficiency scores. Clustering method such as Samoilenko and Osei-Bryson (2008) is one alternative to increase homogeneity, yet due to our intention to present regional-based insights we focus on separate regional DEA assessment. Moreover, due to unbalanced data available from Microfinance Information Exchange (MIX)[1], we hereby utilise a regional meta-frontier approach, i.e. all unbalanced MFI data in each region are assessed together against single regional meta-frontier in that respective region, thus MFI performance in different years are comparable. As far as we concern this is the first MFI efficiency study utilising regional meta-frontier based on VRS hyperbolic non-oriented DEA model in these six regions.

The hyperbolic non-oriented DEA model can be presented in the following:

$$\begin{aligned}
&\min \theta \text{ or } \max \phi \\
&\text{subject to:} \\
&\sum_{j=1}^{n} \lambda_j x_{ij} \le \theta x_{i0}, \quad i = 1, 2, ..., m; \\
&\sum_{j=1}^{n} \lambda_j y_{rj} \ge \phi y_{r0}, \quad r = 1, 2, ..., s; \\
&\sum_{j=1}^{n} \lambda_j = 1, \quad j = 1, 2, ..., n \\
&\lambda_j \ge 0 \\
&\phi = 2 - \theta \\
&\theta, \phi \ge 0
\end{aligned}$$

in which x_{ij} and y_{rj} are the ith input of jth DMU and rth output of jth DMU respectively. θ is the input-minimising efficiency for the particular DMU_0 whilst ϕ is output-maximising efficiency for this DMU_0. Constraint $\phi = 2 - \theta$ is the first-order linear approximation of the constraint $\theta^*\phi = 1$, i.e. a tangent line to the $\theta^*\phi = 1$ hyperbola at any point. Convexity constraint for λ_j, $\sum_{j=1}^{n} \lambda_j = 1$, represents VRS and ensures DMU to be assessed with similarly-sized DMUs in dataset.

3.2. DEA input–output selection

Our DEA model uses three inputs and three outputs; three inputs represent capital and labour in production, i.e. assets (A), operational expenses (O), and employee (E), whilst one output represents sustainability, i.e. interest revenue (Ir), and two outputs represent outreach, i.e. inverse of average loan balance per borrower over GNI per capita (I) and borrower (B). Table 1 presents these along with their definition from MIX. We modified the model used in Widiarto and Emrouznejad (2015), dropping portfolio at risk 30 days from input and replacing financial revenue from output with interest revenue (Ir) the focus herein is on the influence of different loan methodologies to MFI efficiency. This includes 'margin' or profit sharing in Islamic microfinance charged in lieu of interest.

Average loan balance per borrower over GNI per capita is used as in Widiarto and Emrouznejad (2015) as it is a powerful proxy for the depth of MFI outreach, i.e. smaller loan balance signifies that loan is aimed toward the poorest. It is standardised over GNI per capita, thus comparable between countries as purchasing power differences are negated. This is used in inverse format to reflect output properties as per Widiarto and Emrouznejad (2015). We hereby use total number of borrowers as output representing breadth of outreach as per Nghiem, Coelli, and Rao (2006) and Sedzro and Keita (2009), instead of women borrowers as in most MFI studies such as Aggarwal, Goodell, and Selleck (2015) and D'Espallier, Guérin, and Mersland (2011), to preserve homogeneity since Islamic MFIs in dataset focus on family borrowers instead of solely women borrowers (Ahmed, 2002).

3.3. DEA model specifications

Different input–output specifications are used in assessing overall, social, and financial efficiency in Table 2, with their initials as mnemonic. The overall efficiency specification is another advantage of DEA over ratios whereby the latter cannot capture how different inputs simultaneously affect multiple outputs in transformation (Thanassoulis, 2001).

3.4. Tobit regression – second stage analysis

The second stage analysis herein is to evaluate the relationship between regional DEA efficiency with loan methods and other efficiency determinants, which will also include categorical variables. The distribution of DEA efficiency scores can be referred to as corner solution outcomes as DEA efficiency scores are continuous on interval [0,1] or [0,100%] and take on the value of 1 or 100% with positive probability (Hoff, 2007). There is a concentration of observations at the maximum values of since no DMU can be assigned an efficiency scores higher than unity (Chilingerian, 1995).

However, in standard multiple regression the expected errors of such limited dependent variable will be non-zero thus lead to biased estimate (Maddala, 1983). Therefore, Tobit regression (Tobin, 1958) is hereby used as it is designed to evaluate relationships between variables wherein the dependent variable is either censored or corner solution outcomes, which is limited below (at minimum value), above (at maximum value), or both. Notwithstanding its shortcomings (see e.g. Hoff (2007), Samoilenko and Osei-Bryson (2010) and Chilingerian (1995) for in-depth discussion), Hoff (2007) suggested that it will still be adequate in most cases to model the relationship of DEA efficiency with exogenous efficiency determinants. Tobit regression has been widely used in post-DEA analysis in many DEA studies, e.g. in Fethi, Jackson, and

[1] Microfinance Information Exchange (MIX) is the leading microfinance database. It obtains its data from contributing MFIs globally, thereafter adjusted and standardized to make it uniform and comparable. MIX ranks transparency of MFIs in diamond scale from 1 to 5 with 5 diamonds being the most transparent MFIs.

Table 1
DEA inputs–outputs.

Inputs	Initial	Definition	Usage in literatures	Unit
Assets	A	Asset needed in transformation process	Berger and Humphrey (1997), Bassem (2008), Kipesha (2012) and Gutiérrez-Nieto et al. (2009)	USD '000
Operating Expense	O	Expenses related to operations, e.g. personnel expenses, administrative expenses.	Gutiérrez-Nieto et al. (2007), Berger and Humphrey (1997), Gutiérrez-Nieto et al. (2009), Hassan and Sanchez (2009) and Athanassopoulos (1997)	USD '000
Employee	E	Labour input, i.e. all individuals employed by MFI, including contract employees or advisor whether or not listed on MFI employee roster	Athanassopoulos (1997), Berger and Humphrey (1997), Bassem (2008), Hassan and Sanchez (2009), Sedzro and Keita (2009), Kipesha (2012), and Haq et al. (2010)	Numerical

Outputs	Initial	Definition	Usage in literatures	Unit	MFI Objective (Efficiency) Represented
Interest Revenue	Ir	Revenue from loan portfolio, including margin rate charged in Islamic microfinance loan.	Modification from literatures. Many literatures, e.g. Gutiérrez-Nieto et al. (2009) and Hassan and Sanchez (2009) use financial revenue.	USD '000	Sustainability (Financial Efficiency)
Inverse of Average Loan Borrower	I	Inverse format of average loan balance per MFI borrowers to represent *depth of outreach*; standardized over gross national income (GNI) per capita to remove currency & purchasing power parity difference. Used in inverse format to have characteristic as output	Modification from literatures. Gutiérrez-Nieto et al. (2009) use average loan borrower as index with number of borrower.	%	Outreach (Social Efficiency)
Borrowers	B	The number of individual or entity who currently has outstanding loan balance with MFIs or is primarily responsible for repaying any portion of the Gross Loan Portfolio.	Modification from literatures. Most literatures use number of women borrowers, e.g. Cull et al. (2007) and Nghiem et al. (2006).	Numerical	Outreach (Social Efficiency)

Table 2
DEA specifications.

DEA specifications (Mnemonic)	Efficiency specifications	Input variables	Outputs variables
AOE-IrIB	Overall efficiency	• Assets (A) • Operating expenses (O) • Employees (E)	• Interest revenue (Ir) • Inverse of Average loan balance per Borrower over GNI per capita (I) • Number of borrowers (B)
AOE-Ir	Financial efficiency	• Assets (A) • Operating Expenses (O) • Employees (E)	• Interest revenue (Ir)
AOE-IB	Social efficiency	• Assets (A) • Operating Expenses (O) • Employees (E)	• Inverse of Average loan balance per Borrower over GNI per capita (I) • Number of borrowers (B)

Weyman-Jones (2002), Mallikarjun et al. (2014) Islam, Bäckman, and Sumelius (2011), Ruggiero and Vitaliano (1999), Wang and Huang (2007) and Chilingerian (1995).

The Tobit regression model utilised herein is as follows:

$$\begin{aligned} TE_i = {} & \alpha + \beta_1 Borrowing_i + \beta_2 Borrowing_i^2 \\ & + \beta_3 Donationall_i + \beta_4 Donationall_i^2 + \beta_5 CPB_i + \beta_6 PAR30 \\ & + \beta_7 PAR90 + \beta_8 Yieldreal_i + \beta_9 Yieldreal_i^2 \\ & + \beta_{10} Individual_i + \beta_{11} Individual_i^2 + \beta_{12} Group_i \\ & + \beta_{13} Group_i^2 + \beta_{14} Village_i + \beta_{15} Village_i^2 \\ & + \gamma_1 GroupDummy_i + \gamma_2 VBankDummy_i \\ & + \gamma_3 IndivGroupDummy_i + \gamma_4 IndivVBankDummy_i \\ & + \gamma_5 GroupVBankDummy_i + \gamma_6 AllMethodDummy_i \\ & + \gamma_7 Bank_i + \gamma_8 CUCoop_i + \gamma_9 NBFI_i \\ & + \gamma_{10} OtherForm_i + \gamma_{11} MFIAge_i + \gamma_{12} Regulation_i \end{aligned}$$

$$TE_i = \begin{Bmatrix} TE_i^* \text{ if } 0 < TE_i^* < 100 \\ 0 \text{ if } TE_i \le 0 \\ 100 \text{ if } TE_i \ge 100 \end{Bmatrix}$$

Three basic loan methods are included in the regression as independent variables (independent, group, and village) in original and squared forms and also as six dummy variables for seven loan method combinations. Inclusion of squared term in several variables herein is to observe whether curvilinear relationship to efficiency exists. Additionally, to construct a ranking of loan methods vis-à-vis efficiency in each region, the model includes six dummy variables for seven loan methods (three basic methods and four loan combinations with individual loan as base), i.e. to answer the main question of 'best loan method' regionally. These two points will be the main focus of this study. Seven loan method and combinations observed are as follow:

1. Individual lending
2. Group lending
3. Village banking
4. Combination of individual and group lending
5. Combination of individual lending and village banking
6. Combination of group lending and village banking
7. Combination of all three loan methods

The rest of the variables included in the Tobit model are explained in Appendix B.

4. Dataset

Dataset used is unbalanced annual 2003–2012 MIX data of 1461 DMUs from 628 not-for-profit MFIs in 87 countries spread out in six regions: Africa, EAP, EECA, LAC, MENA and SA. DMUs in the MENA region exclude Iran and six Gulf Cooperation Council (GCC) countries due to data unavailability. Table 3 presents DMU classification by loan method for each region. Interestingly, only in SA

Table 3
Summary of dataset by loan method.

Loan method & combinations	Africa		East Asia & The Pacific (EAP)		Eastern Europe & Central Asia (EECA)		Latin America & The Caribbean (LAC)		Middle East & North Africa (MENA)		South Asia (SA)	
	No of DMU	%	No of DMU	%	No of DMU	%	No of DMU	%	No of DMU	%	No of DMU	%
Individual Loan	26	14.44	45	27.95	132	65.02	202	36.59	38	30.65	67	27.80
Group Loan	12	6.67	53	32.92	8	3.94	12	2.17	6	4.84	90	37.34
Village Banking Loan	11	6.11	0	0.00	1	0.49	15	2.72	0	0.00	30	12.45
Individual & Group Loan	90	50.00	60	37.27	53	26.11	114	20.65	79	63.71	37	15.35
Individual & Village Banking Loan	9	5.00	3	1.86	5	2.46	66	11.96	0	0.00	11	4.56
Group & Village Banking Loan	3	1.67	0	0.00	0	0.00	4	0.72	0	0.00	5	2.07
All Methods	29	16.11	0	0.00	4	1.97	139	25.18	1	0.81	1	0.41
	180	**100.00**	**161**	**100.00**	**203**	**100.00**	**552**	**100.00**	**124**	**100.00**	**241**	**100.00**

that group lending is still used by majority of DMUs; in EECA and LAC vast majority of DMUs employ individual loan method. Conversely, majority of DMUs for Africa, EAP and MENA offer both individual and group loan. Thus, group lending is no longer dominates microfinance offering as it were in the early growth of microfinance. Even in SA, individual lending becomes the second widely-used method.

All monetary data in the dataset are in US Dollar hence comparable. As inputs and outputs data have very different scale, mean normalization as per Sarkis (2007) is used in DEA analysis, i.e. by dividing each value in a variable with their mean:

$$X_{Norm_{i0}} = X_{i0}\left[\left(\sum_{n=1}^{N} X_{in}\right)N^{-1}\right]^{-1}$$

where X_{i0} is value of variable i of observed DMU_0, N is the total number of DMU in sample, and $X_{Norm_{i0}}$ is the mean-normalized value of variable i of observed DMU_0.

This method is not the only method to standardize the data for DEA yet this is the widely-used one (Talluri & Yoon, 2000), e.g. used in Gocht and Balcombe (2006), Revilla, Sarkis, and Modrego (2003), Sarkis and Cordeiro (2001), and Talluri and Yoon (2000). Other methods in data standardization used in e.g. Jahanshahloo, Lotfi, Shoja, Tohidi, and Razavyan (2005) and Hashimoto and Kodama (1997).

For the second stage analysis, in order to simplify coefficient interpretations all independent variables are centred to their mean by subtracting all observation data by their mean, thus placing zero at the centre of the data range. Numerical data are represented in the unit of USD 100,000.

5. First stage analysis: non-oriented hyperbolic DEA – regional meta-frontier

Summary of DEA results is presented in Table 4a. Under regional meta-frontier approach, all DMUs from various years in each region are assessed against single regional meta-frontier hence comparable. Whilst mean overall and financial efficiency in all regional meta-frontiers are generally above 60%, with almost all DMUs exhibit first quartile (Q1) scores higher than 50%, we find that the lowest financial efficiency in Africa, EECA, LAC, and SA to be below 10% – the lowest being in Africa of 0.24%. These certainly show very wide gaps between the most- and least-efficient DMUs vis-à-vis sustainability in these regional meta-frontiers albeit on average satisfactory.

In contrast, mean social efficiency scores in most regional meta-frontiers are observed to be below 55% except for EAP (57.74%) and MENA (relatively high mean of 63.05%). The gaps are also wide – the lowest social efficiency observed in all but EAP regional meta-frontier to be below 10% (the lowest being 2.39% in MENA). These, plus low Q1 and median scores, suggest a generally poor performance of DMUs in dataset vis-à-vis outreach, thus a performance boost is vital. DMUs exhibiting very poor outreach warrant further study.

Financial efficiency is observed to have higher correlation to overall efficiency in all but MENA regional meta-frontier, i.e. above 79% on average. It thus suggests a general tendency toward financial objective over social objective amongst DMUs observed, confirming Gutiérrez-Nieto et al. (2009). The exception is MENA wherein correlation of social efficiency to overall efficiency is stronger, i.e. 74.28% vs 55.05%. In this study, overall efficiency is proposed as a measure of overall performance, yet supplemented closely by financial and social efficiency measures to understand MFI's positioning toward its dual objectives.

Fully-efficient DMUs, i.e. those reaching 100% efficiency thus become benchmarks for similarly-sized DMUs in their respective regional meta-frontiers, consist of DMUs utilising different loan methods. We initially expected that DMUs employing mostly used loan method in a particular region will dominate as benchmark DMUs. As per Tables 3 and 4b, consistent results to this are observed in EECA, LAC, Africa and MENA. However, DMUs using individual lending are also found dominating benchmark DMUs in all efficiency measures in SA and EAP despite domination of other lending methods therein; it is a counter-intuitive finding considering SA is the birthplace of group lending.

We also presumed based on Cull et al. (2007), that DMUs employing individual loan dominate benchmark for financial efficiency, whilst those employing group and village banking loan for social efficiency. Indeed, mostly individual lending DMUs are observed as benchmark for financial efficiency in EECA, LAC, SA, and EAP (albeit almost on par with group lending DMUs in EAP). In MENA and Africa, however, DMUs combining individual and group lending dominate as financial efficiency benchmark. Regarding social efficiency, contrary to expectation group lending or village banking DMUs do not dominate as benchmark in all regional meta-frontiers; they are on par with individual lending DMUs in EAP and SA. Individual lending DMUs even dominate social efficiency benchmark in EECA whilst DMUs using loan combinations in the rest. These findings challenge generalisation; group and village banking MFIs may not always dominate as benchmark DMUs (i.e. best-performing DMUs) for outreach.

Subsequently, we plot DMU social and financial efficency scores in social-financial efficiency matrix (SFE matrix) for each region as proposed by Widiarto and Emrouznejad (2015). The SFE matrix is divided into four quadrants, i.e. quadrant I in top right region for high social – high financial efficiency region counterclockwise to quadrant IV in bottom right region for high social – low financial efficiency. Designed to be user-friendly for MFI stakeholders and to complement overall efficiency measure, this matrix is simple yet informative to monitor DMUs positioning toward their dual objectives so that performance improvement can be pursued. DMUs in the SFE matrix are then

Table 4a
Summary of DEA efficiencies.

Regions	DMU	Efficiencies	Mean	Min	TE score quartiles			Correlation with Overall TE
					25%	50%	75%	
Africa	180	Overall TE VRS	72.52	10.34	56.52	72.66	93.42	
		Financial TE VRS	67.48	0.24	52.22	67.31	85.39	0.88543
		Social TE VRS	35.75	3.98	12.45	25.85	49.00	0.56532
East Asia & the Pacific (EAP)	161	Overall TE VRS	80.44	37.85	66.18	82.75	100.00	
		Financial TE VRS	73.86	29.13	61.19	72.55	91.44	0.79761
		Social TE VRS	57.74	10.09	37.86	51.64	77.78	0.68261
Eastern Europe & Central Asia (EECA)	203	Overall TE VRS	70.01	20.01	55.09	68.09	86.70	
		Financial TE VRS	63.62	4.76	48.39	61.18	78.00	0.91118
		Social TE VRS	45.02	4.08	28.31	41.20	60.00	0.69710
Latin America & the Caribbean (LAC)	552	Overall TE VRS	70.98	8.78	57.47	70.80	84.34	
		Financial TE VRS	64.85	7.71	54.45	65.51	77.50	0.79153
		Social TE VRS	43.60	6.09	26.79	36.60	55.71	0.61389
Middle East & North Africa (MENA)	124	Overall TE VRS	84.26	39.65	74.45	89.10	100.00	
		Financial TE VRS	85.06	32.35	77.19	91.27	97.53	0.55054
		Social TE VRS	63.05	2.39	40.30	64.69	88.09	0.74281
South Asia (SA)	241	Overall TE VRS	71.44	16.08	59.15	70.73	83.88	
		Financial TE VRS	63.63	7.44	50.06	62.15	77.50	0.83958
		Social TE VRS	51.48	8.13	35.96	48.28	64.07	0.72122

Table 4b
Summary of fully-efficient benchmark DMUs by loan method.

Regions	DMU	Efficiencies	Fully-efficient DMUs by loan method type[a]							
			Total	1	2	3	4	5	6	7
Africa	180	Overall TE VRS	36	2	6	–	18	3	–	7
		Financial TE VRS	30	2	3	–	10	2	–	3
		Social TE VRS	14	1	4	–	8	1	–	–
East Asia & the Pacific (EAP)	161	Overall TE VRS	41	19	16	–	6	–	–	–
		Financial TE VRS	25	12	11	–	2	–	–	–
		Social TE VRS	28	11	11	–	6	–	–	–
Eastern Europe & Central Asia (EECA)	203	Overall TE VRS	34	23	2	–	7	–	–	2
		Financial TE VRS	23	18	1	–	2	–	–	2
		Social TE VRS	14	9	2	–	2	–	–	1
Latin America & the Caribbean (LAC)	552	Overall TE VRS	49	20	5	3	2	9	1	9
		Financial TE VRS	28	18	3	–	2	3	–	2
		Social TE VRS	24	5	3	3	–	8	–	5
Middle East & North Africa (MENA)	124	Overall TE VRS	36	11	4	–	21	–	–	–
		Financial TE VRS	15	7	–	–	8	–	–	–
		Social TE VRS	20	6	4	–	10	–	–	–
South Asia (SA)	241	Overall TE VRS	29	11	5	7	3	3	–	–
		Financial TE VRS	17	7	1	3	3	3	–	–
		Social TE VRS	17	7	3	7	–	–	–	–

[a] 1 = individual loan; 2 = group loan; 3 = village banking loan; 4 = combination of individual and group loan; 5 = combination of individual and village banking loan; 6 = combination of group and village banking loan; 7 = combination of all loan methods.

classified by their loan methods. Based on Cull et al. (2007), Hermes and Lensink (2007b), and Navajas, Schreiner, Meyer, Gonzalez-vega, and Rodriguez-meza (2000), our main hypothesis herein is that DMUs using solely individual loan to have higher financial efficiency whilst DMUs employing solely group or village banking to have higher social efficiency. Yet, in regard to lending combinations, we can only establish hypothesis that DMUs combining all loan methods to have higher financial efficiency, as per Hermes et al. (2011). As overall efficiency is found to be highly correlated to financial efficiency, we establish equivalent presumption hereto. The ideal quadrant is quadrant I of high social – high financial efficiency as DMUs therein able to strive for social and financial efficiency concurrently.

In regional SFE matrices in Fig. 1, barring MENA regional metafrontier, most DMUs are mapped at quadrant II of low social – high financial efficiency, including in EAP and SA where DMUs are clustered around the border of quadrant I and II with slightly more in quadrant II. Whilst these suggest a relatively satisfactory performance toward financial sustainability, their positions in quadrant II nonetheless signify weak performance vis-à-vis social efficiency, or mediocre at best as in the case of SA where DMUs are mostly at the border of quadrant I and II.

This is quite alarming since social efficiency is fundamentally regarded as *raison d'être* of microfinance; it distinguishes MFI from traditional financial institution – particularly for not-for-profit MFIs. Many African, EECA, LAC and SA DMUs are also mapped at quadrant III, showing poor performance on both efficiencies. In contrast, most MENA DMUs are mapped in quadrant I, i.e. a generally satisfactory performance in both objectives.

By classifying DMUs based on loan methods, findings disprove our presumption: an absolute generalisation across all regions cannot be established regarding loan methods – efficiency relationship. For example, many village banking DMUs in Africa and group lending DMUs in SA are plotted at quadrant II and III (low social efficiency), whilst many individual lending DMUs in African and SA are mapped at quadrant III (low financial and social efficiency).

Intuitively, DMUs employing combination of group or village banking with individual lending, or those combining all methods

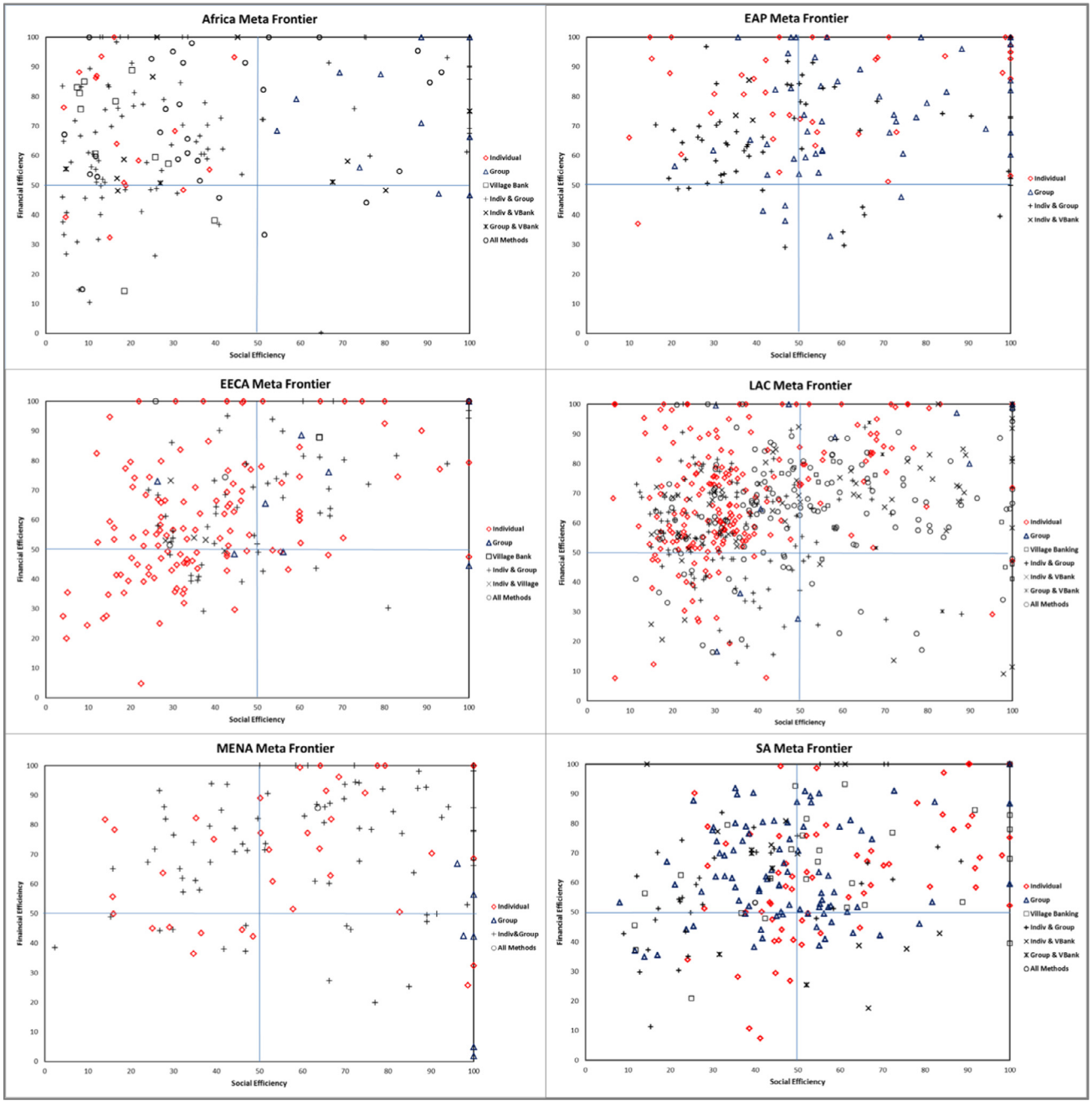

Fig. 1. Social – financial efficiency (SFE) matrices for six regional meta-frontiers.

(as per our presumption) should be located in quadrant I, yet empirical findings challenge this notion.

We therefore cannot confirm generalisation of one loan method over another as single best method for microfinance globally as we observe different loan methods/combinations in quadrant I in different regional meta-frontiers. These necessitate a post-DEA assessment to investigate which method generally delivers higher efficiency measures in each region.

6. Second stage analysis: Tobit regression

In line with study objectives, the analysis will be focused on the loan methods – efficiency relationship, with brief summary on findings for other factors.

6.1. Loan method relationship to efficiency

Results summarised in Table 5 show that individual loan method have significant positive linear relationship to financial efficiency of not-for-profit MFIs in all but SA regional meta-frontier, consistent with initial presumption. It is also consistent with presumption by having significant negative linear relationship to social efficiency in African regional meta-frontier, suggesting that increasing individual loan hurts outreach to the poor as individual loan usually features higher average loan balance and collateral requirement. This correlates with individual lending DMUs' positioning at quadrant II and III in Africa.

Interestingly, individual loan challenges presumption by positively correlated with social efficiency in EAP and LAC. It also has convex relationship in MENA and concave relationship in SA,

Table 5
Tobit regression coefficients – loan methods.

	Africa			EAP			EECA		
	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency
Individual	0.0260641	0.0677872	−0.04794	0.2259296	0.188291	0.216551	0.165632	0.126234	0.052824
	[0.352]	[0.013][b]	[0.121][d]	[0.003][b]	[0.003][b]	[0.017][b]	[0.008][b]	[0.033][b]	[0.349]
Individual squared	0.0000116	−0.0000236	0.000038	−0.0001562	−0.00012	0.000038	−0.00016	−0.00011	−0.00002
	[0.718]	[0.453]	[0.264]	[0.477]	[0.395]	[0.898]	[0.06][b]	[0.165]	[0.809]
Group	0.1396255	0.0705433	0.244823	0.0867047	0.046793	0.136408	0.388205	0.339451	0.154028
	[0.013][b]	[0.158]	[0.000][a]	[0.086][c]	[0.331]	[0.018][b]	[0.01][b]	[0.02][b]	[0.282]
Group squared	−0.0001099	−0.0000454	−0.00024	0.000055	0.000239	−0.000139	−0.0014	−0.00112	−0.00088
	[0.054][c]	[0.382]	[0.000][a]	[0.715]	[0.096][c]	[0.396]	[0.064][c]	[0.13][d]	[0.235]
Village	0.7765556	0.4895829	1.180382	−1.769759	−1.06909	−1.017674	2.222186	2.349085	−1.61753
	[0.014][b]	[0.11][d]	[0.001][b]	[0.646]	[0.785]	[0.826]	[0.2]	[0.182]	[0.292]
Village squared	−0.0058604	−0.0039959	−0.00833	0.0359396	0.022402	0.009818	−0.02895	−0.03605	0.027549
	[0.081][c]	[0.22]	[0.028][b]	[0.77]	[0.858]	[0.947]	[0.271]	[0.178]	[0.231]
Dummy variables for loan methods:									
Group Loan	18.18123	4.013998	36.10391	−0.4414859	3.010004	4.106721	3.438791	−1.30637	12.07702
	[0.025][b]	[0.594]	[0.000][a]	[0.922]	[0.5]	[0.44]	[0.735]	[0.895]	[0.227]
Village Banking Loan	−23.34147	−17.80987	−26.5259				3896.536	4993.236	−3821.57
	[0.007][b]	[0.038][b]	[0.008][b]				[0.282]	[0.175]	[0.227]
Individual & Group Loan Combi	2.843853	4.332787	−0.74168	−6.468379	−5.16581	−4.850714	−0.31182	−4.94101	6.29806
	[0.542]	[0.348]	[0.891]	[0.159]	[0.256]	[0.371]	[0.953]	[0.346]	[0.231]
Individual & Village Banking Combi	−14.58848	−15.45832	−14.8032	21.67201	17.838	15.84514	−32.6561	−30.4489	16.77099
	[0.141][d]	[0.11][d]	[0.189]	[0.231]	[0.332]	[0.466]	[0.232]	[0.27]	[0.505]
Group & Village Banking Combi	−32.31518	−29.06026	−30.6792						
	[0.013][b]	[0.025][b]	[0.043][b]						
All Loan Method Combi	−8.891292	−3.519451	−15.8096				13.16755	24.99871	7.518227
	[0.179]	[0.588]	[0.038][b]				[0.346]	[0.072][c]	[0.57]

	LAC			MENA			SA		
	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency
Individual	0.0122647	0.0079981	0.009261	0.078719	0.065148	−0.012761	0.0228186	0.013823	0.040286
	[0.008][b]	[0.109][c]	[0.046][b]	[0.007][b]	[0.04][b]	[0.755]	[0.185]	[0.435]	[0.042][b]
Individual squared	−0.0000011	−0.0000007	−0.000001	0.000007	−0.000052	0.000159	−0.0000033	−0.000002	−0.000006
	[0.152]	[0.447]	[0.165]	[0.856]	[0.17]	[0.011][b]	[0.293]	[0.614]	[0.084][c]
Group	0.2309385	0.1049335	0.265827	0.082364	0.098466	0.08434	0.0506859	0.037761	0.083095
	[0.002][b]	[0.193]	[0.001][b]	[0.022][b]	[0.019][b]	[0.081][c]	[0.079][c]	[0.203]	[0.014][b]
Group squared	−0.000926	−0.000503	−0.00099	−0.000031	−0.00002	−0.000007	−0.0000286	−0.000035	−0.000042
	[0.002][b]	[0.114][d]	[0.002][b]	[0.368]	[0.648]	[0.88]	[0.294]	[0.197]	[0.206]
Village	0.190626	0.0634907	0.407591				0.1743589	0.200972	0.140846
	[0.000][a]	[0.151]	[0.000][a]				[0.002][b]	[0.000][a]	[0.021][b]
Village squared	−0.000383	−0.000122	−0.00076				−0.0001595	−0.000196	−0.000119
	[0.001][b]	[0.326]	[0.000][a]				[0.012][b]	[0.003][b]	[0.098][c]
Dummy variables for loan methods:									
Group Loan	6.980715	9.817253	17.55719	23.84905	−43.14635	45.35036	−5.533652	−0.65404	−17.9451
	[0.172]	[0.068][c]	[0.001][b]	[0.024][b]	[0.000][a]	[0.002][b]	[0.143][d]	[0.866]	[0.000][a]
Village Banking Loan	8.496272	−12.88655	23.76816				−6.8842	−8.42608	−7.28234
	[0.065][c]	[0.008][b]	[0.000][a]				[0.191]	[0.119][d]	[0.235]
Individual & Group Loan Combi	−12.30319	−13.68065	−6.04798	1.897782	0.5303064	4.702107	−9.834916	−3.93544	−21.6142
	[0.000][a]	[0.000][a]	[0.007][b]	[0.686]	[0.919]	[0.469]	[0.03][b]	[0.397]	[0.000][a]
Individual & Village Banking Combi	−4.041484	−7.972095	0.156735				−0.1748342	−7.72025	−11.0435
	[0.121][d]	[0.004][b]	[0.955]				[0.978]	[0.245]	[0.14][d]
Group & Village Banking Combi	−1.976478	−11.63971	2.611017				−16.29915	−13.1766	−23.025
	[0.82]	[0.196]	[0.772]				[0.048][b]	[0.123][d]	[0.019][b]
All Loan Method Combi	−5.855726	−7.3241	−2.51834	−31.00332	−27.38276	−3.83288	−20.18322	−10.7535	−22.414
	[0.007][b]	[0.002][b]	[0.278]	[0.31]	[0.371]	[0.896]	[0.247]	[0.552]	[0.278]

[a] Significant at 99.99% confidence interval.
[b] Significant at 95% confidence interval.
[c] Significant at 90% confidence interval.
[d] Significant at 85% confidence interval.

though the latter with very small coefficient. Convex relationship in MENA suggests that extending individual loan up to certain amount may reduce social efficiency scores, but it will start to rise beyond that amount. Due to the social efficiency specification used, if an MFI extend/increase offering of individual loan its social efficiency decreases due to shift in focus from poorest to better-off borrower with higher loan balance (less depth of outreach), i.e. mission drift, up to a point beyond which individual loan takes over as major method for MFI, and breadth of outreach, i.e. number of borrowers, starts to offset the effect of declining depth and increases its social efficiency scores. In our result for MENA, keeping other variables at their means, this critical amount is USD 19 million. Concave relationship in SA on the contrary suggests that extending/increasing individual loan offering

increases outreach due to breadth of outreach offsetting depth up to a point beyond which outreach breadth will eventually decrease as MFIs may vet for more quality clients, as per Cull et al. (2007). However, due to its very small concavity in Table 5, the graphical depiction will almost be identical to a linear positive relationship.

Regarding overall efficiency, individual loan as expected exhibits significant positive relationship in EAP and MENA regional meta-frontiers. It also shows significant and marginally significant concave relationships in EECA and LAC regional meta-frontiers, respectively.

Contrary to presumption, group loan shows significant positive linear relationship to financial efficiency in Africa and MENA regional meta-frontiers, whilst exhibits convex relationship in EAP regional meta-frontier and concave relationship in EECA and LAC regional meta-frontiers. Concave relationship in these two regions suggests that offering group loan increases financial efficiency but up to a certain amount, beyond which it decreases due to higher transaction costs associated with managing group loans as stated in many literatures, e.g. Conning and Morduch (2011). With other variables constant at means, financial efficiency start to decrease after group loan reaching approximately USD 30 million and USD 12 million in EECA and LAC regional meta-frontiers, respectively. In EAP regional meta-frontier, convex relationship is exhibited whereby offering group loan initially reduces financial efficiency due to transaction costs entails until it reaches USD 7.5 million, beyond which financial efficiency starts to increase since interest revenue starts to offset transaction costs.

Against overall efficiency, group loan exhibits contrary findings to presumption with positive linear relationship in EAP, MENA, and SA regional meta-frontiers and concave relationship in EECA, LAC, and African regional meta-frontiers; the latter with very small concavity. Its concave relationship in EECA and LAC suggests that overall efficiency starts to fall after reaching USD 28 million and USD 12 million, respectively; almost identical to its relationship to financial efficiency due its close correlation.

Consistent with presumption, group loan exhibits significant positive linear relationship with social efficiency in EAP, MENA, and SA regional meta-frontiers. Our model shows that concave relationships are observed in African and LAC regional meta-frontiers, indicating that maximum amounts exist for group loan beyond which social efficiency starts to fall. From the model, group loan larger than USD 14 million in LAC region will start reducing the social efficiency, whilst very small concavity in African region means that increasing/offering group loan increases social efficiency until roughly USD 68 million before it start to decrease. These findings are consistent with presumption for these two regions yet up to a point. There are many reasons that may cause this that warrant further regional investigation.

Village banking method challenges presumption regarding financial efficiency by exhibiting significant positive linear relationship in African and LAC and concave relationship in SA regions. Our finding in SA shows that, due to its very small concavity, financial efficiency increases by offering village banking loan until USD 83 million then decreases thereafter. This may be due to the higher transaction costs in managing village banking MFIs, as suggested in studies e.g. Westley (2004). Village banking also challenges presumption regarding overall efficiency by exhibiting significant concave relationships in abovementioned three regions, i.e. offering village banking loan increases overall efficiency albeit until some maximum amounts therein. Other variables constant at means, this model suggests a maximum amount of USD 10.5 million in Africa, USD 28 million in LAC and USD 94 million in SA before overall efficiency starts to plummet. It also has concave relationship to social efficiency in these three regions, consistent to presumption albeit limited to maximum amounts. Maximum amount before social efficiency begins to fall are USD 7.5 million, USD 31 million, and USD 62 million in African, LAC, and MENA frontiers, respectively. These last results may be an indirect effect of village banking's high costs, yet it needs thorough regional study.

Interestingly, we find that offering/increasing group loan in MENA and also group and village banking loan combination in Africa enables non-profit DMUs in dataset to increase financial efficiency faster than individual loan, with village banking loan increases financial efficiency the fastest amongst the three basic methods. Similarly, we also find offering group loan in EECA until USD 12 million assists small-scale DMUs to increase financial efficiency, before plummetting thereafter. On the contrary, we observed that offering/increasing individual loan in EAP region helps non-profit DMUs in dataset to increase social efficiency faster than group loan due to number of borrowers reached (breadth of outreach). These findings support our argument that loan method impact is not clear cut to all regions due to regional differences.

6.2. Loan method ranking

As presented in Appendix B and Table 6, findings from dummy variables for seven loan combinations show that different loan methods top the ranks in different regions, i.e. there is no single method that has ultimate advantage in all regions or in any efficiency specification. Indeed, group lending comes out first in overall and social efficiency in African and MENA regional meta-frontiers and also in financial efficiency in LAC regional meta-frontiers, but it is village banking loan in the latter region that tops the overall and social efficiency. Group loan also sits first in different efficiency in different regions but not single-handedly; it is on par with other methods in top position due to insignificant differences with other methods in the same position. For instance, group loan is on par with individual loan, loan combination 4 (combination of individual and group loan) and loan combination 7 (combination of all loan methods) in financial efficiency in African regional meta-frontier. Conversely, for financial and social efficiency in EAP and also for overall and social efficiency in EECA, we cannot find significant differences between different loan methods.

Equally, we observe that individual loan do not top the rank in financial or other efficiency in any region by itself. It ranks first in financial efficiency in African, MENA, and SA regional meta-frontiers and also in overall and social efficiency in SA regional meta-frontier, but it ties with several loan methods/combinations due to insignificant differences thereto.

Thus, in our dataset of not-for-profit MFIs we can only confirm with notion of best loan method in regional context, not globally. We indeed observe group lending as best method of microfinance as in Ahmed (2002) in terms of overall and social efficiency, yet only in African and MENA regional meta-frontiers. Similarly, we cannot confirm Cull et al. (2007) suggesting individual lending as best method in financial efficiency as group lending prevails in LAC regional meta-frontier and group loan is on par with individual loan and other combination methods in African, EAP, and SA regional meta-frontiers.

We can confirm Westley (2004) and Hiatt and Woodworth (2006) in the scope of LAC that village banking is relatively best method in terms of overall and social efficiency.

There are no significant performance differences amongst all seven loan methods in EAP vis-à-vis financial and social efficiency, albeit group, individual lending and combination of individual and village banking loan top the overall efficiency. No significant differences amongst methods also observed in overall and social efficiency in EECA regional meta-frontier, although combination of all three methods came first in financial efficiency, confirming Hermes et al. (2011). Interestingly, group lending is not listed in the top ranks for overall, financial and social efficiency in SA regional meta-frontiers, whilst individual lending is one of the

Table 6
Loan method ranking – six regional meta-frontiers.

Rank	Africa			EAP			EECA		
	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency
1	Group Loan	Group Loan Individual Loan Loan Combo 4 Loan Combo 7	Group Loan	Group Loan Individual Loan Loan Combo 5	No significant differences between methods	No significant differences between methods	No significant differences between methods	Loan Combo 7	No significant differences between methods
2	Individual Loan Loan Combo 4 Loan Combo 7	Loan Combo 5	Individual Loan Loan Combo 4 Loan Combo 5	Loan Combo 4				Group Loan Individual Loan Village Banking Loan Loan Combo 4 Loan Combo 5	
3	Loan Combo 5	Village Banking Loan	Loan Combo 7						
4	Village Banking Loan	Loan Combo 6	Village Banking Loan						
5	Loan Combo 6		Loan Combo 6						

Rank	LAC			MENA			SA		
	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency	Overall efficiency	Financial efficiency	Social efficiency
1	Village Banking Loan	Group Loan	Village Banking Loan	Group Loan	Individual Loan Loan Combo 4 Loan Combo 7	Group Loan	Individual Loan Village Banking Loan Loan Combo 5 Loan Combo 7	Individual Loan Group Loan Loan Combo 4 Loan Combo 5 Loan combo 7	Individual Loan Village Banking Loan Loan Combo 7
2	Individual Loan Group Loan Loan Combo 4 Loan Combo 5 Loan Combo 6 Loan Combo 7	Individual Loan Loan Combo 6	Group Loan	Individual Loan Loan Combo 4 Loan Combo 7	Group Loan	Individual Loan Loan Combo 4 Loan Combo 7	Group Loan	Village Banking Loan	Loan Combo 5
3		Loan Combo 7	Individual Loan Loan Combo 5 Loan Combo 6 Loan Combo 7				Loan Combo 4	Loan Combo 6	Group Loan
4		Loan Combo 5	Loan Combo 4				Loan Combo 6		Loan Combo 4
5		Village Banking Loan							Loan Combo 6
6		Loan Combo 3							

Loan Combo 4: Combination of Individual and Group Loan.
Loan Combo 5: Combination of Individual and Village Banking Loan.
Loan Combo 6: Combination of Group and Village Banking Loan.
Loan Combo 7: Combination of all loan method.

methods topping the rank for all these efficiency measures. This is a counter-intuitive result considering SA as birthplace of group lending. Conversely, village banking is also listed herein amongst methods providing best performance in overall and social efficiency.

6.3. Other factors in Tobit model to efficiency

From Appendix C, we find contrary to our presumption that borrowings and total donations (sum of cash and equity donations) do not always have linear positive relationship to efficiency. Borrowings exert negative relationship with overall efficiency in EAP and MENA and with social efficiency in MENA. Concave relationship is observed in Africa and MENA where borrowings contribute positively to efficiency but up to a point. Similarly for total donations; findings in some regions show concave relationship where total donations help efficiency to certain amount; or convexity showing minimum total donations amount is needed before it can assist efficiency. However, findings on total donation are contingent to our DEA specification for financial efficiency with interest revenue as sole output representing sustainability.

Interest rate does not simply correlate positively to financial efficiency in all frontiers as intuitively suggested; indeed positive relationships are found in LAC and MENA whilst convex relationship is observed in EAP. Interestingly, convex relationship to social efficiency is found in almost all frontiers, i.e. social efficiency is decreasing along with interest rate hike until reaching a rate beyond which social efficiency is starting to increase again. One possible explanation is that high interest rates part correlates with group and village banking lending; whilst rising interest rates in individual lending reduce breadth of outreach. Regarding legal format, MFI age, and MFI regulation, generalisation cannot be established amongst not-for-profit MFIs for all frontiers.

7. Conclusions and direction for future research

Based on our findings, we conclude that the concept of “best loan method” for not-for-profit MFIs cannot be generalised for all frontiers. Instead, empirical evidence shows that different frontiers may have different preferences due to different environment. It also shows that several loan methods and method combinations can exhibit equivalent performance in different frontiers. As an example, group lending is the best method in achieving highest overall and social efficiency in Africa and MENA, yet it is village banking that prevails in these efficiency measures in LAC. We also find that three basic loan methods of individual loan, group loan, and village banking loan exert different relationship to efficiency in different regional meta-frontiers. In addition to linear relationship, curvilinear relationships are also observed in some regions, both convex and concave. These show that loan method – efficiency relationships are not as straightforward as may intuitively suggested from literatures. Based on findings, the optimum loan amount providing higher efficiency for these three basic methods can be

calculated for each region. This can serve as recommendation to MFIs in constructing their loan strategy.

Not-for-profit DMUs in all regions in this study show generally satisfactory financial efficiency scores. However, in terms of social efficiency most DMUs in all but MENA regional meta-frontier are found to perform less satisfactorily, i.e. achieving average scores of less than 50%. Since outputs representing social efficiency resemble depth and breadth of outreach, this should serve as a wake-up call for MFIs and regulators in improving MFIs performance in terms of outreach to the poor. Overall efficiency is generally found to be closely related to financial efficiency in all but MENA regional meta-frontier. Thus, using overall efficiency as general performance benchmark can only be used cautiously; it must be augmented by financial and social efficiency scores to provide better pictures.

From results presented in Appendix C and mentioned briefly in the previous section, our findings on other factors related to efficiencies, i.e. borrowings, total donation, CPB, PAR 30, PAR 90, interest rates, MFI age, regulation status, and legal format, support our argument that appropriate performance analysis should best be done on regional basis separately as we find different results for different region.

Finally, we propose that future microfinance efficiency study to explore efficiency determinants to be performed in regional basis globally as it may provide more useful insights. Qualitative field study is also recommended to complement or to support quantitative analysis as it enhances the understanding of analysis results.

Further classifications of DMU based on second stage variables and graphical depictions of loan methods – efficiency relationships are available from authors.

Supplementary materials

Supplementary data associated with this article can be found, in the online version, at 10.1016/j.eswa.2017.03.022.

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