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The Determinants of the Efficiency of Microfinance Institutions in Africa

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Abstract: Over the past few decades, microfinance institutions have attracted the interest of governments and academics alike, given their unique nature of being financial institutions with a dual mission of promoting social development and reducing poverty. However, concerns have been raised about their effectiveness in achieving these goals while remaining financially sustainable. In this study, we attempt to examine the factors that have the greatest impact on the social, financial, and overall efficiency of microfinance institutions in African regions. We adopt a two-step approach: First, we assess the efficiency scores of 95 microfinance institutions in Africa between 2005 and 2018 using a data envelopment analysis (DEA) approach. We then regress their efficiency scores on a set of determinant variables, capturing the microfinance institutions' characteristics. Our findings suggest that a majority of institutions prioritize profitability over social outreach. Furthermore, the panel data regression indicates that factors such as profitability, equity capitalization, types of loans, and low gross domestic product (GDP) have a positive influence on microfinance institutions' efficiency. Conversely, variables including their risk portfolio, grants, microfinance institution status (Non-Governmental Organization (NGO), cooperative, etc.), operational area, political environment, and size exert a negative impact on efficiency. Through this study, we seek to enhance our understanding of microfinance institutions and to identify the factors that impact their operational efficiency, thereby reinforcing their crucial role in advancing financial inclusion, empowering marginalized communities, and fostering inclusive economic growth.

Keywords: microfinance institution; social efficiency; financial efficiency; DEA; panel data

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1. Introduction

A microfinance institution (MFI) is an organization that offers multiple financial services (loans, savings, grants, etc.) to individuals who are normally excluded from traditional financial channels, specifically in communities with low incomes, with the idea of achieving financial profit while promoting social development. From this point of view, microfinance plays a complementary role to the classic banking system by developing innovative lending initiatives and, in particular, solidarity loans, flexible loans, small loans with a dynamic incentive, progressive loans, and frequent repayments. Despite their perceived risks and costs, these techniques have the potential to enhance financial inclusion and reduce poverty by empowering individuals to participate more actively in the economy.

The idea of microfinance can be traced back to the works of Dr. Yunus (Noble Prize winner in 2006), whose contributions have firmly established that even a small amount of funds can have a profound impact on the lives of the underprivileged and those in need by helping them to launch new initiatives or expand their enterprises to generate more income.

Over the last few decades, the success of microfinance, particularly in developing countries, has sparked the interest of governments and academics alike due to the unique

idea that a financial institution can simultaneously pursue profit and social development. Cull et al. (2007) estimate that microfinance covers 180 million borrowers, mainly concentrated in the global South, and that the amount of assets managed by microfinance institutions is approximately USD 190 billion. This fast growth of microfinance institutions all over the world has raised many questions about how to assess their performance (Lapenu et al. 2004; Hudon and Balkenhol 2011) and their efficiency in fulfilling their dual mission: being financially viable while helping individuals with low incomes. These interrogations are mainly led by public and private funders and donors, as well as other stakeholders who want to ensure their funds and donations to these institutions are effectively utilized for their intended purpose and have a meaningful impact. As a result of being a hybrid organization that combines two different objectives (Sommeno et al. (2024)), assessing an MFI's performance can prove to be very challenging, since only a few MFIs are financially self-sufficient and their share of non-market resources is generally very significant. Therefore, evaluating the performance of MFIs simply through the lens of financial indicators such as profitability and neglecting social factors proves to be of little relevance. Alternatively, Balkenhol (2007) suggests that this analysis can be more fruitful by shifting our focus to efficiency.

This article evaluates the efficiency of 95 microfinance institutions in Africa and explores the factors influencing these efficiency levels to provide a comprehensive understanding of the dynamics of MFIs. We adopt a two-step approach following Coelli (1998), which involves regressing data envelopment analysis' efficiency scores on explanatory factors using linear regression.

While most studies on MFI efficiency use data from multiple continents, each with unique contexts, we focus specifically on Africa to enhance the applicability of the DEA approach. And, similar to Gutiérrez-Nieto et al. (2009), we examine three forms of efficiency—financial, social, and overall—to accommodate the hybrid nature of microfinance institutions in Africa.

The following sections of the article are organized into five main parts. We begin by exploring the concept of efficiency in the microfinance sector and proposing hypotheses on variables that could significantly impact efficiency scores. The second and third sections outline our two-step approach and describe the data collection process. The fourth section presents the results obtained. Finally, we conclude with a discussion and interpretation of our findings.

2. Literature Review

2.1. The Microfinance Institutions' Efficiency

An organization's efficiency is determined by its ability to achieve maximum outputs with minimum inputs. This means effectively utilizing resources such as funds, manpower, and time to generate the best possible results. In the case of microfinance institutions, their efficiency is closely tied to balancing two operating logics—private and collective—due to their hybrid nature and dual orientation (financial and social) (Mumi et al. (2020). Being efficient, for these institutions, involves minimizing costs, maximizing profit, and extending social outreach to fulfill their dual mission of providing sustainable financial services to excluded communities. The question of an MFI's efficiency has sparked debate between two opposing positions, shifting from a social welfare-focused vision of microfinance in the 1980s to a more commercially oriented one (Woller et al. 1999; Morduch 2000).

This institutionalist vision is based on the belief that financial sustainability, high returns, and reaching the poorest are compatible. This view favors the elimination of grants to microfinance to fit better with the logic of the financial markets (Rhyne 1998). On the other hand, the institutionalist vision has the advantage of denouncing the failures of certain programs, which have been forced to end because of rigorous management. However, the arguments developed by its followers conflict with reality, as only 5% or less of MFIs are financially autonomous (UNCF 2005; Deutsche Bank 2007), and grants still play a major role in the MFI operating structure (Costello 2024; Hudon and Traca 2011).

Moreover, the optimal strategy, which holds that microfinance should be profitable while reaching poor individuals, is strongly questioned.

Solely relying on financial ratios to assess efficiency provides limited insights for microfinance institutions managers, as noted Lam et al. (2020). Reciprocity between financial and social performance in microfinance institutions, as detailed in *Public Performance & Management Review* 43: 206–31, has led to the development of two approaches to applying DEA to evaluate the efficiency of West African MFIs. The results of these studies showed that the majority of the institutions observed were inefficient in both their social and financial aspects, mainly attributed to poor resource management.

Bassem (2014) conducted a study on the efficiency of 33 MFIs in North Africa using the DEA method for the period 2006 to 2011. The study found that the observed institutions experienced an annual increase of 4.9%, primarily attributed to changes in technical efficiency. Technical efficiency refers to how MFIs allocate their resources to enhance their performance. Essentially, the right combination of inputs can improve overall MFI performance.

In a similar vein, Kipesha (2012) evaluated the efficiency of MFIs from five East African countries (Tanzania, Kenya, Uganda, Rwanda, and Burundi) using the DEA approach with constant and variable return assumptions. The sample included 35 MFIs, comprising 5 banks, 17 non-bank financial institutions (NBFIs), 9 Non-Governmental Organizations (NGOs), and 4 cooperatives for the period 2009 to 2011. In our study, we have examined three forms of efficiency, financial, social, and overall, utilizing a production approach with three input variables (total assets, staff, and operating costs) and two output variables (Gross Loan Portfolio and Financial Revenue).

2.2. Determinants of Microfinance Institutions' Efficiency

The empirical literature has explored several factors impacting the efficiency of microfinance institutions. We have considered a set of key determinants frequently discussed, which can be reviewed as follows:

- The experience or the age of the MFI: The relationship between the MFI's experience level and its efficiency is not simple. According to life cycle theory, efficiency may improve with institutional maturity. Older MFIs tend to have lower operational ratios than newer ones, as they have honed their management practices through trial and error. González et al. (2007) found that older MFIs benefit from refined management techniques. On the other hand, younger MFIs can leverage new technologies and innovations, potentially making them more efficient in adopting new management information systems and developing mobile banking platforms (Cornée and Thenet 2016; Wijesiri et al. 2017). However, mature organizations may become entrenched in outdated processes, hindering their efficiency. In light of the existing literature, we hypothesize that the experience of an MFI has a positive effect on its social, financial, and overall efficiency.
- The legal status of MFIs (or Jurisdictional form (JF)): The legal status of MFIs can also significantly impact their efficiency. The works of Gutiérrez-Nieto et al. (2007), Haq et al. (2010), and Abdelkader (2023) indicate that NGOs tend to focus on social efficiency, whereas bank-oriented MFIs prioritize financial profitability (Morduch 2000; Adair and Berguiga 2010; Mersland and Strøm 2009; Lafourcade 2005; Hassan and Sanchez 2009). Consequently, we hypothesize that NGO status is related positively to social efficiency and negatively to financial efficiency.
- Impact of grants (SUB): MFIs prioritizing social missions over profitability often rely on government and donor grants. According to Cull et al. (2007), subsidized MFIs have an advantage in reaching extremely poor clients. However, other studies show a negative relationship between subsidies and financial results. Bogan (2012) found that the increased use of subsidies in large MFIs decreased their operational self-sufficiency. Our hypothesis suggests that grants improve social efficiency but decrease financial efficiency.

- Lending type (individual/group lending) (LT): Individual lending models, while less costly and labor-intensive than group lending, are more common in urban areas where borrowers are less poor and seek loans for productivity purposes (Ledgerwood 1999). However, individual loans serve self-employed individuals rather than the poorest. Conversely, group loans are more likely to be repaid, as borrowers can use group members' pressure as a substitute guarantee to ensure loan repayment (De Aghion and Morduch 2005). We postulate that both loan types ensure loan repayment. Thus, the type of loan would have a positive impact on social efficiency and financial efficiency.
- Portfolio at risk (PAR): According to Sa-Dhan (2003), the portfolio at risk provides a pessimistic estimate of the default risk in MFI loan portfolios. Institutions with high PARs experience significantly lower net interest income and profitability rates. Sambili and Ngeno (2018) indicate that high-risk portfolios substantially reduce income from credit operations and negatively impact financial efficiency (Singh 2024). Moreover, this affects MFIs negatively, as it hinders access to debt financing from investors and donors. We hypothesize that high-risk portfolios significantly reduce income from credit operations and impair MFIs' ability to fulfill their social mission, negatively affecting both social and financial efficiency.
- Return on assets or profitability (RA): Return on assets is a ratio obtained by dividing net income by total assets. During the last few years, many microfinance institutions have prioritized financial goals over social objectives (Tang et al. 2020). This focus on financial outcomes has mostly guaranteed the survival of MFIs due to the radical slowdown of the funds contributed by governments and donors (Nourani et al. 2021); thus, we assume that profitability positively affects financial and social efficiency.
- Equity capitalization (EC): The ratio of equity to total assets indicates the financial health of MFIs. Bogan (2012, cited by Sambili and Ngeno (2018)) shows that well-capitalized MFIs are the most efficient financially and socially as they can attract commercial capital easily. We hypothesize that well-capitalized MFIs achieve both social and financial efficiency; therefore, there exists a positive relationship between equity capitalization and MFIs' efficiency.
- Gross domestic product (GDP): This serves as a proxy for the socio-economic environment in which MFIs operate (Chasmar 2009; Ahlin et al. 2011; González et al. 2007; Hartarska and Nadolnyak 2007). The relationship between GDP and MFI efficiency is complex. According to (Kablan 2012; Solhi and Rigar 2014) there is a significant positive relationship, suggesting that a higher GDP correlates with increased borrower incomes, facilitating larger loan amounts and ensuring repayment. However, other studies show no significant relationship and are rather resilient to economic shocks. We hypothesize that a lower GDP has a negative relationship between GDP and financial and social efficiency.
- Operational area (ZONE): According to the study of (Solhi and Rigar 2014; Cornée and Thenet 2016), MFIs targeting rural populations and underserved urban areas achieve higher financial and social efficiency. Serving populations without access to banking services enhances their operational effectiveness. Thus, there is a positive relationship between the operational area and both financial and social efficiency.
- Political environment (EP): Political stability enhances trust in the financial market, allowing MFIs to secure better financing and improve their financial efficiency. However, several studies indicate that a stable environment often results in MFIs being less effective in targeting the ones in need. We can assume that political stability positively affects financial efficiency, while it negatively impacts social efficiency.
- Several studies on the efficiency of MFIs have focused on the potential trade-off between financial efficiency (EF) and social efficiency (SE). Some research suggests a negative relationship between social outreach and financial viability (Louis et al. 2013; Pedrini and Ferri 2016). Conversely, other studies found no evidence of compromise, while some even identified a positive relationship between financial and social efficiency (Gakhar 2016; El Azzazy 2024). While the relationship between the social and

financial objectives of MFIs is still a topic of debate, most studies suggest a negative correlation between social and financial efficiency.

3. Methodology

The main focus of the study is to comprehend the MFIs' efficiency dynamic and its determinants in the African region. The use of Data Envelopment Analysis scores in linear modeling is a common approach. Academic examples[1] illustrate how DEA scores can be effectively used in regression models as they can provide valuable insights for difficult-to-measure variables like social outreach, organizational impact, and qualitative performance indicators. To this end, we follow a two-step approach: first, we measure the efficiency scores of MFIs using the specification of different DEA models, we then examine the main key factors of efficiency via panel data modeling by regressing the obtained scores on a series of explanatory variables.

3.1. An Overview of Data Envelopment Analysis (DEA)

In this work, we used a "Data Envelopment Analysis" (DEA), a "non-parametric" approach for relatively estimating the efficiency scores of decision-making units (DMUs) based on linear programming modeling. It has the advantage of benchmarking multi-dimensional inputs and outputs with no need to specify a mathematical form for the production function.

Moreover, the DEA estimation can be applied under two main hypotheses: Constant Returns to Scale (CRS), assuming all institutions (DMUs) operate at their optimal size, and the Variable Returns to Scale model, also referred to as the Variable Returns to Scale (VRS), assuming all organizations do not operate at their optimal size. The VRS estimation allows for variations in the scale of production or operation, better reflecting real-world characteristics, where increasing inputs may not always lead to proportional increases in outputs, which proves to be a more practical setting to adapt for this study.

Mathematically, the Variable Returns to Scale for a for a single DMU can be represented by the formula

$$Max_{\{\lambda,\theta)}\ \theta$$

subject to

$$\sum_{\{j=1\}}^{m} \lambda_j x_{\{ij\}} \ \leq \theta\ x_{\{is\}} \qquad \forall i$$

$$\sum_{\{s=1\}}^{s} y_{is} = \sum_{\{j=1\}}^{m} \lambda_j x_{\{ij\}} \qquad \forall j\ x_{\{ij\}}$$

$$\lambda_j\ \geq 0, \theta \geq 0$$

where

- λ_j: non-negative weight or multiplier for input j of *DMUi.*
- θ: efficiency score indicating the maximum output that *DMUi* can achieve relative to its inputs.
- $x_{\{ij\}}$: amount of input used by *DMUi*.
- y_{is}: amount of output s produced by *DMUi*.

The solution to this linear programming problem evaluates the efficiency of DMUs (which are the MFIs in our study) by comparing their capacity to transform inputs into outputs. However, for larger datasets, it is essential to utilize a professional statistical program. In our case, we employed the R software[2], allowing us to evaluate each MFI relative to its peers in the same region (see Appendices A and B).

Selection of Inputs and Outputs

Input selection is based on the production approach, where financial institutions use manpower and physical resources to process transactions such as grant loans or

receive deposits, much in the same way in which a factory would use capital and labor to manufacture products for selling. After thoroughly reviewing the literature on DEA and financial institutions, we have settled for three inputs and four outputs that differ according to the model type (see the Table 1).

Table 1. Efficiency measurement models.

Model Type	Structure	Variables
Financial efficiency model	Inputs	Total assets
		Staff
		Operating costs
	Outputs	Financial income
		Loan portfolio
Social efficiency model	Inputs	Total assets
		Staff
		Operating costs
	Outputs	% of women borrowers
		Average loans granted
Overall efficiency model	Inputs	Total assets
		Staff
		Operating costs
	Outputs	Financial income
		Loan portfolio
		% of women borrowers
		Average loans granted

The selected inputs are the "*total assets*", which are largely used in the literature as a proxy for the capital factor (Solhi and Rigar 2014); the "*staff*", measured by the total number of employees, reflecting the important role that loan officers and other employees play in the operation and success of institutions; and the "*operating costs*", which are the operating expenses related to the MFI's functioning. On the financial side, "*Financial income*" and the "*loan portfolio*" are essential outputs that allow financial institutions to generate a financial return while ensuring their sustainability in the market. For the social aspect, a variety of proxies are suggested for evaluating their social outreach. Given the lack of harmonized social indicators, we have selected the most common variables in the literature like "*Percentage of women borrowers*"; studies indicate that the microfinance institution services offered were found to have a decisive influence on empowering disadvantaged and poor women by improving their livelihood and the development of their business (Abebe and Kegne 2023). The correlation analysis also indicated a positive and significant association between saving practices, access to credit, skill development training, and the development of women entrepreneurs. Also, the "*number of borrowers*" reflects the outreach of the program, i.e., the capacity of the institution to use its resources to serve the maximum number of clients.

The overall efficiency model refers to the combined efficiency of achieving both financial and social objectives. It reflects the integration of financial sustainability with social outreach. Essentially, an MFI is considered efficient overall if it achieves a good balance between profitability and its social impact.

In summary, while our financial and social efficiency models are more clearly defined, "overall efficiency" covers the holistic assessment of an MFI's performance in fulfilling its objectives.

We established a total of three efficiency models, one for every type of efficiency, under a Variable Returns to Scale hypothesis. Regarding the orientation of the models, the initial objective of an MFI is to achieve maximum impact (maximum output) using limited resources (inputs), which is aligned with an output orientation. However, the choice also depends on the quantities of inputs and outputs that managers can manage. For microfinance institutions, it is evident that managers have much more control over inputs than outputs. Therefore, and following the example of previous studies, we established input-oriented models where MFIs seek to minimize inputs for a given weight of outputs.

3.2. Panel Data Regression

The panel data represent a combination of time series and cross-sections, allowing for a consideration of the various aspects of heterogeneity in the dynamism of the MFIs. Note that panel data regression is a continuation of the previous data envelopment analysis, with the main purpose of assessing the MFIs' efficiency in African regions.

In order to study the effect of different factors on the efficiency of MFIs, three equations were established, for which the endogenous variables are represented by the efficiency scores estimated previously.

$$EF_{it} = \alpha_{it} Iv + \beta_{it} Fv + \delta_{it} EMv + \gamma_{it} ES + \varepsilon_{it} \quad (1)$$

$$ES_{it} = \alpha_{it} Iv + \beta_{it} Fv + \delta_{it} EMv + \phi_{it} EF + \varepsilon_{it} \quad (2)$$

$$EG_{it} = \alpha_{it} Iv + \beta_{it} Fv + \delta_{it} EMv + \phi_{it} EF + \gamma_{it} ES + \varepsilon_{it} \quad (3)$$

To make the models' equations easy to read, we have classified the variables into sets according to their type, where EF: financial efficiency; ES: social efficiency; EG: overall efficiency; Iv: institutional variables; Fv: financial variables; EMv: environmental/macroeconomic variables; α_{it}, β_{it}, δ_{it}, ϕ_{it}, γ_{it}: respectively, the coefficients for each variable for the ith MFI at time t; and ε_{it}: an error term.

The Table 2 provides a brief description of each variable separately.

Table 2. Description of variables.

Type	Abv.	Variable	Description	Unit of Measurement
Efficiency of MFIs	EF	Financial efficiency	Measured by the financial efficiency score (VRS)	Percentage
	ES	Social efficiency	Measured by the social efficiency score (VRS)	Percentage
	EG	Overall efficiency	Measured by the overall efficiency score (VRS)	Percentage
Financial variables	PaR	Portfolio at risk	Portfolio at risk > 30 days/loans portfolio	Percentage
	RA	Return on assets	Calculated by dividing the net profit generated by the MFI by the total assets	Percentage
	EC	Equity capitalization	The ratio of equity to total assets	Percentage
Institutional variables	SUB	Subvention	Whether the MFI receives grants (binary variable)	-
	FJ	Juridical form	Organization status of the MFI (ONG—Bank—Cooperation—FNB) (categorical variable)	-
	LT	Loan type	The loan technique used by the MFI (categorical variable)	-
	Zone	Geographic operating zone	The MFI's operating area (rural—urban)	-
	EXP	Experience	The difference between observation year (2018) and the birth date	Number
Environmental/Macroeconomic variables	EP	Political environment	A score based on the stability and political condition of the country in which the MFI operates	Percentage
	GDPc	Gross domestic product per capita	The GDP per capita is a measure of a country's economic output that accounts for its number of people	Percentage

Furthermore, we estimated three types of models for each equation—ordinary least squares (OLS), fixed effects models (LSDV and Within), and random effects models—for each type of efficiency (EF, ES, and EG). The first type assumes that all MFIs in Africa have an identical structure (full homogeneity). The second type is a fixed-effects model (LSDV and Within), which takes into account the characteristic of heterogeneity by specifying a different constant (fixed coefficients) for each individual (MFI). With the random effect model, the individual fixed coefficients become variable, adding the residual component w_{it} to represent the variability of each individual. It is necessary to choose an appropriate structure, using the selection test, to adequately explain their efficiency.

4. Data and Variables

Our sample contains 1330 observations, comprising data from 95 microfinance institutions from five regions of Africa and covering the years 2005 to 2018, the same regions as those used in the previous analysis. The majority of MFIs concentrate on Eastern and Western regions, representing 24% and 36% of the MFIs studied, respectively. Other countries such as Tunisia and Angola are represented by a single institution. The selection of MFIs by country is based on the number of institutions existing in each country and the transparency level of the data available in the Mixmarket database[3]. To avoid biased estimations, we exclude incomplete data that could hinder the scoring work for our DEA analysis and panel modeling. We focused exclusively on African MFIs whose financial information exhibits a very high level of reliability on the Mixmarket website. Our choice of Africa was based on various reasons, notably the maintenance of data homogeneity by selecting countries with cultural and socio-economic similarities. Furthermore, the African continent contains a mature and well-developed microfinance sector where a plurality of actors coexist, differing notably in their status and aims. The following Table 3 details the MFIs distribution by country and region.

Table 3. Distribution of African MFIs by region.

Regions	Countries	Number of MFIs	MFIs
EAST	Ethiopia	3	Buusaa Gonofaa, PEACE, Wasasa
	Kenya	6	Equity Bank KEN, Family Bank KEN, Faulu MFB, Jamii Bora, Sidian Bank, VisionFund Kenya
	Rwanda	2	Umutanguha Finance Company (UFC), Ltd-Urwego Bank
	Tanzania	5	Akiba, BRAC—TZA, FINCA—TZA, Opportunity Tanzania, PRIDE—TZA
	Uganda	7	BRAC—UGA, Centenary Bank, Finance Trust, FINCA—UGA, Opportunity Uganda, UGAFODE, VisionFund Uganda
WEST	Benin	6	ACFB, FECECAM, PADME, RENACA, SIA N SON, Vital Finance
	Burkina Faso	3	FCPB—BFA, GRAINE sarl, PAMF-BFA
	Ghana	6	ID Ghana, KSF, OISL, PanAfrican Savings and Loans, Sinapi Aba Trust, WWB Ghana
	Mali	3	CVECA Pays Dogon, Kafo Jiginew, RMCR
	Niger	5	ASUSU SA, COOPEC Hinfani Dosso, Kokari, MECREF, Accion MfB Nigeria
	Nigeria	6	DEC, Grooming Centre, Hasal MFB, LAPO-NGR, SEAP, ACEP Senegal
	Sengal	4	Baobab Sénégal, PAMECAS, U-IMCEC, CECA
	Togo	3	FUCEC Togo, UMECTO, WAGES

Table 3. *Cont.*

Regions	Countries	Number of MFIs	MFIs
CENTRAL	Angola	1	KixiCredito
	Cameroon	4	ACEP Cameroon, Advans Cameroun, CamCCUL, SOFINA SA
	Congo	3	CAPPED, FINCA—DRC, Hekima, PAIDEK
AUSTRAL	Madagascar	5	AccèsBanque Madagascar, CECAM, MicroCred—MDG, Otiv Tana, PAMF-MDG
	Malawi	3	CUMO, FINCA—MWI, OIBM
	Mozambique	5	AfricaWorks, CCOM, Hluvuku, MBC, SOCREMO
	Zambia	2	FINCA—ZMB, MicroLoan Foundation Zambia
NORTH	Egypt	5	ABA, Al Tadamun, CEOSS, DBACD, Lead Foundation
	Morocco	6	Al Amana, Al Karama, Attadamoune, ATTAWFIQ MICRO-FINANCE, Fondation Albaraka, INMAA
	Tunisia	1	Enda Tamweel

5. Empirical Results

In this section, we shall present our general observations and findings, including the DEA score estimates (see Appendix A) for 95 African MFIs between 2005 and 2018. Our results show that the efficiency estimates for the five African regions were relatively similar. Also, the financial efficiency model presents higher scores under the variable return assumption compared to the social model.

Moreover, the social scores vary inversely to the financial scores, which indicates a negative correlation between social and financial efficiency. This finding is also consistent with the literature (Gutiérrez-Nieto et al. 2009; Serrano-Cinca et al. 2011). More generally, our finding is in line with the work of Ullman (1985), who carried out an exhaustive review of empirical work on the link between financial and social performance in several microfinance sectors around the world and came to the conclusion that there is an equivocal relationship. Furthermore, the estimates of the overall efficiency of MFIs are closer to those of financial efficiency than to social efficiency, which can be attributed to the strong dependence of the MFI's performance on profitability rather than social outreach.

5.1. Financial Efficiency

According to the estimates presented in Table 4, the signs of most of the variables are more or less similar for the four estimated models. Thus, at the significance level, variables such as ES, EXP, PaR, and RA have *p*-values less than 5%, indicating that these variables contribute strongly to the explanation of the evolution of the financial efficiency of MFIs, regardless of the form of the model used.

Based on the selection tests (see Appendices A and B), the LSDV assumption emerges as the most suitable and representative. Consequently, our interpretations will mainly rely on its estimations, as the LSDV model is the most appropriate. Social efficiency (SE) has a positive and highly significant impact at a 1% *p*-value; increasing social efficiency by one percentage point leads to a 0.089 change in financial efficiency.

Of the financial variables, equity capitalization has a positive impact, but is statistically insignificant (*p*-value less than 5%) and therefore does not contribute to explaining the MFIs' financial performance. The portfolio at risk has a negative effect, hindering the MFIs' financial efficiency; an increase in the PaR of 1 percent decelerates the EF by 0.205 percent. On the other hand, profitability positively affects the MFIs' financial efficiency with a high and significant coefficient equal to (0.390).

Table 4. Estimation of the financial efficiency panel model.

Variables	Model			
	OLS	**LSDV**	**Within**	**Random**
(Constant)	0.511 ***	2.094 ***	-	0.699 ***
t-stat	7.247	7.338		4.869
ES	0.136 ***	0.089 ***	0.089 ***	0.099 ***
t-stat	9.915	4.913	4.913	5.904
EXP	0.004 ***	0.015 ***	0.015 ***	0.007 ***
t-stat	4.806	8.265	8.265	6.306
EC	−0.006	0.019	0.019	0.019
t-stat	−0.401	1.136	1.136	1.148
PaR	0.159 *	−0.205 **	−0.205 **	−0.186 **
t-stat	2.494	−3.236	−3.23	−2.990
RA	0.335 ***	0.390 ***	0.390 ***	0.395 ***
t-stat	7.058	8.474	8.474	8.709
LT (I)	0.035	0.066	-	0.059
t-stat	1.377	0.737		0.911
LT (M)	0.072 ***	0.071	-	−0.0724
t-stat	4.702	1.180		−1.849
FJ (C)	−0.093	−0.031	-	−0.369
t-stat	−1.643	−0.321		−0.369
FJ (NBFC)	−0.0269	−0.042		−0.040
t-stat	−1.617	−0.490		−0.958
FJ (ONG)	−0.073	−0.180 **	-	−0.046
t-stat	−1.350	−2.950		−0.33
SUB (O)	−0.092 .	−0.037	-	0.082
t-stat	−1.662	−0.365		0.582
ZONE (U)	0.026 *	−0.106 .	-	0.023
t-stat	2.093	−1.79		0.748
EP	−0.001 **	0.001 **	0.001 **	0.000
t-stat	−3.041	2.729	2.72	0.724
GDPc	0.027 ***	0.184 ***	0.184 **	−0.006
t-stat	3.343	4.794	4.794	−0.344
R-Squared	0.178	0.52	0.14	0.11
F-Statistic	20.390 ***	13.624 ***	28.78	190.97 ***

Significance codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1.

For the institutional variables, the coefficient of the EXP variable which represents the age of the institution is positive and highly significant, meaning that one more year of experience improves the financial efficiency of the MFI by 0.015; the estimates also show that the use of individual loans has no significant effect on financial efficiency, even though the coefficient has the expected sign (positive). The NGO's legal status shows a significantly negative impact of 0.180, indicating the incompatibility of this form with an institution that favors profits. Thus, from a statistical point of view, the grant variable is insignificant, even though it has an expected negative effect, while the Zone (urban) variable is negatively significant at a threshold of 10%. For the macro-environmental variables, the political environment has a significantly weak effect on financial efficiency (close to 0); as for GDP, the estimate indicates that it significantly influences FE with a positive coefficient of (0.184).

5.2. Social Efficiency

The optimal model for social efficiency is the random effects model. According to the results shown in the Table 5, it appears that the coefficient of financial efficiency is highly significant, which means that any increase of 1 percentage point results in a positive variation of 0.233 in social efficiency. The financial variables (EC, PaR, and RA) are insignificant because their p-values are greater than 5%, which may be due to the incompatibility of this type of variable with a social model. Concerning the institutional variables, unlike the financial efficiency model, the EXP variable seems to negatively impact social efficiency with a significant coefficient of 0.008, while the coefficient estimated for the individual loan mode is positive and significant only at a threshold of 10%.

Table 5. Estimation of the social efficiency panel model.

Variables	**Model**			
	OLS	**LSDV**	**Within**	**Random**
(Constant)	−0.035	−0.784 .	-	−0.040
t-stat	−0.254	−1.729		−0.136
EF	0.509 ***	0.216 ***	0.216 ***	0.233 ***
t-stat	9.915	4.913	4.913	5.435
EXP	−0.004 *	−0.011 ***	−0.011 ***	−0.008 ***
t-stat	−2.217	−3.783	−3.783	−4.076
EC	0.171 ***	0.013	0.0135	0.0246
t-stat	5.464	0.504	0.504	0.930
PaR	−0.112	−0.129	−0.129	−0.112
t-stat	−0.904	−1.303	−1.303	−1.142
RA	−0.292	−0.052	−0.0529	−0.072
t-stat	−3.137	−0.718	−0.718	−0.992
LT (I)	−0.073	−0.548 ***	-	0.096
t-stat	−1.476	−3.899		0.648
LT (M)	0.078 **	−0.007	-	0.067
t-stat	2.617	−0.0803		0.748
FJ (C)	0.676 ***	1.585 ***	-	0.620
t-stat	6.210	11.031		1.878
FJ (NBFC)	0.043	8.274 ***	-	0.0630
t-stat	1.345	6.198		0.650
FJ (ONG)	0.469 ***	7.465 ***	-	0.401
t-stat	4.480	7.998		1.267
SUB (O)	0.312 **	0.206	-	0.220 *
t-stat		2.925		0.683
		1.284		
ZONE (U)		0.066 **	−0.027	0.054
t-stat	2.696	−0.293		0.74
EP	−0.001 **	−0.000	−0.000	−0.000
t-stat	−2.673	−0.048	−0.048	−0.367
GDPc	0.011	0.110	0.110	0.0507
t-stat	0.698	1.824	1.82	1.408
R-Squared	0.165	0.68	0.032	0.041
F-Statistic	18.626 ***	26.965 ***	5.825 ***	57.051 ***

Significance codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1.

The NGO's legal status has a positive effect of 0.401 on social efficiency and a low level of significance (p-value < 10%). The estimation of the grant variable shows that grant

funding positively influences the social efficiency of an MFI with a significant value of 0.220. Likewise, the zone of operation (urban) positively affects social efficiency (0.054), but statically this variable is not significant. The estimates for the macro-environmental variables are generally statistically insignificant, with a negative impact (close to 0).

5.3. Overall Efficiency

Although the overall efficiency model has the same optimal structure as the social efficiency model (random effect), the parameter estimation shown in Table 6 indicates similar results (in terms of signs) to the financial efficiency model. However, the significance of the variables is weak compared to the previous models, which may be due to the biased estimation of the model in general.

Table 6. Estimation of the overall efficiency panel model.

Variables	Models			
	OLS	**LSDV**	**Within**	**Random**
(Constant)	0.320 ***	0.898 ***	-	0.352 ***
t-stat	8.854	5.558		5.617
EF	0.613 ***	0.631 ***	0.631 ***	0.630 ***
t-stat	44.320	39.933	39.933	42.54
ES	0.149 ***	0.163 ***	0.163 ***	0.154 ***
t-stat	20.923	16.100	16.100	17.38
EXP	−0.001 *	0.002 *	0.002 *	−0.0002
t-stat	−1.963	2.522	2.522	−0.462
EC	−0.017 *	0.011	0.011	0.0041
t-stat	−2.107	1.203	1.203	0.466
PaR	0.041	−0.029	−0.029	−0.010
t-stat	1.268	0.035	−0.845	−0.321
RA	0.104 ***	−0.004	−0.004	0.025
t-stat	4.302	−0.179	−0.1794	1.009
LT (I)	0.0283 *	0.079	-	0.031
t-stat	2.197	1.569		1.181
LT (M)	0.023 **	0.050	-	0.0225
t-stat	2.944	1.503		1.428
FJ (C)	−0.041	−0.044	-	−0.030
t-stat	−1.430	−0.821		−0.5314
FJ (NBFC)	−0.009	−0.185 ***	-	−0.011
t-stat	−1.1747	−3.833		−0.672
FJ (ONG)	−0.029	−0.029	-	−0.016
t-stat	−1.088	−0.858		−0.291
SUB (O)	−0.013	−0.145 *	-	−0.521
t-stat	−0.478	−2.546		−0.521
ZONE (U)	−0.023 ***	0.021	-	−0.0233
t-stat	−3.713	0.661		−1.814
EP	0.000	0.001	0.0006	0.0003
t-stat	0.0529	1.942	1.942	1.618
GDPc	0.002	0.073 ***	0.073 ***	0.004 .
t-stat	0.615	3.407	3.407	0.546
R-Squared	0.729	0.811	0.654	0.671
F-Statistic	236.50 ***	51.640 ***	290.70 ***	2688.31 ***

Significance codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1.

6. Discussion

These empirical findings confirm that financial efficiency (FE) is positively influenced by profitability, equity capitalization, loan type (individual or group), experience, and environment stability, while it is negatively affected by the portfolio at risk, grants, NGO legal status, and operating zone (rural or urban). Profitability significantly enhances the financial efficiency of microfinance institutions, as profitable MFIs can acquire capital at lower costs, leading to higher returns.

The results also confirm that MFI capitalization positively affects both financial and social efficiency. The more highly capitalized the MFI, the more funds it has available to cover itself against the significant risks that result from lending activities.

Furthermore, the type of loan has a positive impact on both the financial and social efficiency of MFIs. Group-based loans, in particular, are more likely to be repaid than individual loans. Borrowers can use the pressure of group members as collateral to ensure repayment of the loan because each member cannot let the others down through the social penalties imposed. In other words, group-based lending ensures a guarantee of repayment and also lowers administrative expenses.

While the age of the institution positively influences its financial efficiency, it concurrently has a negative impact on its social efficiency. These findings are consistent with those of Ahlin and Lin (2006); Mueller and Uhde (2009); and Wijesiri et al. (2017). Although older MFIs perform better than younger ones in terms of achieving financial objectives, they are relatively inefficient in achieving outreach objectives.

Furthermore, there is a significant positive relationship between financial efficiency and GDP per capita, which serves as a proxy for the socioeconomic status of clients, indicating that clients with a higher socio-economic status enhance financial efficiency and performance. Additionally, political stability significantly boosts financial efficiency by fostering trust among market participants, including MFIs, private lenders (banks), and clients.

Theoretically, the main source of risk for any MFI is its unsecured loan portfolio. which is consistent with the negative correlation between the PaR variable and financial efficiency, meaning that a high-risk loan portfolio will reduce the return on microcredit activities and negatively affect the MFI's financial performance.

The results indicate that NGO legal status and grant funding weaken the financial sustainability of microfinance institutions, corroborating the findings of Morduch (2000), Hudon and Traca (2011); D'Espallier et al. (2013); Bogan (2012); and Caudill et al. (2009). Additionally, MFIs operating in rural areas incur higher operating costs, which reduces their profitability. This is consistent with the studies of Mersland and Strøm (2009), Ferro-Luzzi and Weber (2006), and Berguiga (2011).

On another hand, social outreach is profoundly influenced by institutional status (NGO), which can significantly enhance the social outreach of a microfinance bank, particularly by providing access to funding and community engagement, which enable the microfinance institution to reach more underserved populations. This aligns with the findings of Thompson and Hartaska (2008) and Besley and Ghatak (2005), who argue that donor support ensures that NGOs can sustain their social missions over time. Moreover, MFIs operating in rural areas are more likely to target the poorest members of society. This geographic targeting strategy, supported by Welfare theorists, enhances the social efficiency of MFIs, corroborating our research findings.

Maintaining very high-risk portfolios could significantly reduce income, thus hindering microfinance institutions from fulfilling their social mission. Our results indicate that profitability adversely affects social efficiency, implying that more profitable MFIs tend to provide more loans to less impoverished clients, thereby systematically reducing their social impact. These findings align with those of Solhi and Rigar (2014) and Kablan (2012), in contrast to the findings of Lebovics et al. (2016).

Funding from governments and donors appears to adversely affect the social efficiency of MFIs, as it can sustain inefficient institutions only in the short term (Conning 1999).

The age of MFIs proves to have a negative impact on their social performance: the more mature an MFI, the less it tends to favor social outreach. Conversely, mature MFIs often present greater financial efficiency by managing loan risks effectively and reducing defaults. Additionally, the political environment also negatively influences MFI performance. A stable political climate correlates with lower social scores for MFIs. Political instability in these regions has increased poverty, further complicating outreach efforts.

Finally, it is important to note that the growing emphasis on financial performance over social outreach has sparked a demand for standardized and independent social ratings among donors, managers, and shareholders. They typically seek means that can evaluate both the financial and social orientations of MFIs, ensuring that their actions align with their stated intentions (Urgeghe 2010), which will help guide strategic and operational decisions, promoting a path towards improved alignment and achieving financial sustainability while maximizing social impact.

7. Conclusions

In a constrained environment where sustaining institutions without making a profit is challenging, microfinance proves to be a transformative force. By thriving in the market by providing small-scale financial services such as microloans, savings accounts, and insurance to low-income individuals and entrepreneurs, microfinance empowers people to start or expand small businesses, improve their livelihoods, and build resilience against economic shocks. This inclusive financial approach not only fosters economic independence and self-sufficiency but also stimulates local economies, promotes social stability, and contributes to long-term sustainable development. Microfinance institutions operate much like traditional banks but with a main focus on serving vulnerable communities and individuals aiming to initiate or expand their businesses and projects. Achieving their dual mission of profitability and maximizing their social impact presents significant challenges, particularly when assessing their social dimension, due to limited available social indicators. In this study, our primary goal was to evaluate the efficiency of microfinance institutions in achieving their financial and social roles. Secondly, we aimed to identify the key factors impacting their efficiency.

The study sample includes 95 MFIs from five African regions (2005 to 2018) that share similar social and economic conditions. Using the non-parametric approach of a data envelopment analysis, we estimated three types of efficiency: financial, social, and a third one that combines both into overall efficiency. The estimation result for these models indicates a negative correlation between social and financial efficiency. Additionally, the majority of these MFIs' overall efficiency estimates align more closely with their financial efficiency than with their social efficiency, meaning that these institutions' performance is more strongly influenced by profitability than by social outreach.

In the second part of our empirical study, we continue by regressing the efficiency scores on groups of explanatory variables: financial variables that reflect the organization's financial health and performance, institutional variables related to each MFI's specific characteristics, and environmental/macroeconomic variables that represent external factors that influence economic conditions and business operations. Our panel modeling results prove that African microfinance institutions' financial efficiency is positively influenced by profitability, equity capitalization, loan type, experience, and environmental stability. Conversely, it is negatively impacted by the portfolio at risk (PaR), subvention, NGO legal status, and the operational area. Profitability significantly enhances the financial efficiency of microfinance institutions, as profitable MFIs can acquire capital at lower costs, resulting in higher returns.

The estimates also indicate that an MFI's capitalization positively affects both its financial and social efficiency. Higher capitalization allows MFIs to cover significant risks from lending activities. Additionally, the type of loan impacts MFI efficiency; group loans, in particular, are more likely to be repaid than individual loans due to peer pressure within the group, which acts as a guarantee and reduces administrative costs. Moreover, the maturity of an MFI positively influences its efficiency, likely due to accumulated experience. However, it also limits its social impact, which can be explained by a shift in focus towards

profitability at the expense of social outreach. Through this study, our optimal goal was to deepen our understanding of the world of microfinance by assessing the efficiency of its institutions and identifying factors that could potentially enhance it further and strengthen its role in achieving development objectives by fostering economic growth.

However, all research has limitations, and this study is no exception. Future research could build on this work to deepen our understanding of MFIs. One key limitation is the use of the non-parametric DEA method, which cannot detect random effects and is sensitive to data errors and outliers. Therefore, the careful selection of inputs and outputs is essential for accurate results. Another limitation lies in the focus on unidimensional efficiency, without considering the multidimensionality of efficiency, which includes productive efficiency, allocative (economic) efficiency, and technical efficiency. And last, the limited numbers of variables used were due to the difficulty in gathering data across multiple institutions over extended periods.

Lastly, we hope this research can establish a foundation for future studies seeking to optimize microfinance institutions and enhance their financial viability and social impact. Subsequent research could explore advanced methodologies that incorporate variables such as economic crises or robust social indicators to further refine our understanding.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Estimates of the average efficiency scores (ES, EF, and EG) of the East African region.

	Type of Efficiency	Returns	stat.	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EAST REGION	ES	VRS	Mean	62%	64%	69%	68%	76%	64%	65%	66%	68%	64%	60%	57%	57%	47%
			% Efficients MFIs	43%	48%	52%	43%	57%	48%	39%	35%	35%	39%	30%	35%	35%	30%
	EF	VRS	Mean	79%	80%	86%	88%	87%	88%	92%	90%	95%	95%	90%	85%	89%	88%
			% Efficients MFIs	43%	43%	43%	52%	48%	43%	52%	48%	52%	70%	57%	43%	57%	57%
	EG	VRS	Mean	89%	90%	95%	94%	94%	93%	95%	93%	98%	97%	92%	91%	94%	93%
			% Efficients MFIs	74%	78%	83%	83%	78%	65%	74%	65%	74%	87%	70%	65%	74%	74%

Table A2. Estimates of the average efficiency scores (ES, EF, and EG) of the West African region.

	Type of Efficiency	Returns	stat.	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
WEST REGION	ES	VRS	Mean	41%	44%	42%	43%	40%	39%	48%	43%	39%	38%	39%	45%	41%	40%
			% Efficients MFIs	25%	25%	25%	25%	25%	25%	31%	33%	25%	25%	28%	28%	28%	28%
	EF	VRS	Mean	67%	74%	75%	76%	77%	73%	72%	77%	78%	76%	78%	81%	86%	86%
			% Efficients MFIs	28%	33%	36%	36%	31%	28%	25%	31%	28%	19%	25%	28%	36%	36%
	EG	VRS	Mean	81%	82%	83%	83%	84%	79%	80%	83%	84%	84%	85%	90%	91%	92%
			% Efficients MFIs	50%	53%	56%	50%	50%	44%	42%	50%	47%	44%	47%	53%	56%	56%

Table A3. Estimates of the average efficiency scores (ES, EF, and EG) of the Central African region.

	Type of Efficiency	Returns	stat.	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CENTRAL REGION	ES	VRS	Mean	70%	90%	88%	76%	77%	80%	81%	81%	81%	74%	84%	86%	86%	82%
			% Efficients MFIs	44%	78%	78%	56%	67%	78%	78%	78%	78%	67%	78%	78%	67%	67%
	EF	VRS	Mean	82%	98%	95%	96%	95%	92%	94%	90%	94%	94%	94%	96%	94%	96%
			% Efficients MFIs	44%	78%	67%	78%	78%	67%	67%	56%	78%	78%	78%	78%	67%	67%
	EG	VRS	Mean	90%	100%	100%	98%	97%	96%	97%	96%	97%	97%	98%	99%	99%	100%
			% Efficients MFIs	67%	100%	100%	89%	89%	89%	89%	89%	89%	89%	89%	89%	89%	89%

Table A4. Estimates of the average efficiency scores (ES, EF, and EG) of the austral African region.

	Type of Efficiency	Returns	stat.	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AUSTRAL REGION	ES	VRS	Mean	74%	70%	72%	76%	63%	53%	49%	56%	53%	55%	53%	63%	65%	63%
			% Efficients MFIs	60%	47%	47%	67%	27%	27%	33%	27%	27%	27%	27%	40%	40%	33%
	EF	VRS	Mean	85%	82%	92%	58%	49%	53%	75%	77%	85%	85%	87%	93%	90%	90%
			% Efficients MFIs	53%	53%	53%	33%	53%	27%	33%	33%	40%	47%	53%	73%	60%	60%
	EG	VRS	Mean	96%	92%	97%	82%	69%	63%	79%	81%	87%	91%	88%	94%	91%	92%
			% Efficients MFIs	87%	80%	73%	73%	53%	33%	47%	40%	47%	60%	53%	80%	73%	73%

Table A5. Estimates of the average efficiency scores (ES, EF, and EG) of the North African region.

	Type of Efficiency	Returns	stat.	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NORTH REGION	ES	VRS	Mean	74%	86%	80%	79%	77%	85%	78%	67%	78%	79%	77%	79%	75%	65%
			% Efficients MFIs	58%	67%	67%	67%	50%	75%	58%	50%	58%	50%	50%	50%	50%	42%
	EF	VRS	Mean	84%	89%	91%	92%	90%	95%	96%	94%	91%	93%	94%	93%	92%	94%
			% Efficients MFIs	58%	67%	67%	67%	50%	75%	58%	50%	58%	50%	50%	50%	50%	42%
	EG	VRS	Mean	93%	94%	92%	96%	98%	99%	100%	97%	98%	99%	100%	100%	98%	98%
			% Efficients MFIs	83%	83%	75%	83%	75%	92%	100%	75%	92%	92%	75%	100%	92%	92%

Appendix B

➢ **Selection tests for panel models:**

- **Hsiao tests**

Table A6. Results of model selection tests.

Tests	EF	ES	EG
Fisher 1	10.478 ***	23.789 ***	6.072 ***
	(RH0)	(RH0)	(RH0)
Fisher 2	1.3672	0.57974	0.371
	(AH0)	(AH0)	(AH0)
Fisher 3	2.2624 ***	1.5563 ***	3.560 ***
	(RH0)	(RH0)	(RH0)

Significance codes: '***' 0.001.

- The first Fisher test detects whether there is a total homogeneity of the sample under the null hypothesis of complete homogeneity (an OLS model), meaning all coefficients (constants and slopes) in the models are identical for all individuals.
- The second Fisher test is for determining the source of the existing heterogeneity; we test whether all the coefficients of the model, except the constants, vary between individuals, with the null hypothesis of homogeneity in the slopes.
- The third Fisher test involves testing for the presence of individual effects under the null hypothesis of the absence of individual effects in the model.

- **Hausman test**

Table A7. Results of Hausman test.

Test Stat.	EF	ES	EG
chi-squared	31.728 **	19.305	15.659
	(RH0)	(AH0)	(AH0)

Significance codes: '**' 0.01.

The Hausman test is for choosing between a fixed effects model or a random effects model, based on the null hypothesis that the suitable model is random effects. The alternate hypothesis is that the model has fixed effects.

➢ **Diagnosis of selected models:**

To ensure the reliability of the selected models, we carried out several tests, including the test for an absence of error autocorrelation, the test for error normality, the test for homoscedasticity (stability of error variance), and the test for sequential dependence (Breusch–Pagan LM test).

- **Breusch–Godfrey test:**

Table A8. Result if Breusch-Godfrey test.

Stats	EF	ES	EG
Chisq	404.14	377.48	238.41
p-value	(0.0731)	(0.0599)	(0.0706)

The results of the Breusch–Godfrey test across various models of social, financial, and overall efficiency show critical probability values exceeding the (5%) threshold, which indicates that the errors from all models are not autocorrelated. The hypothesis of no autocorrelation of errors is confirmed.

- **Error normality test (Jarque–Bera test):**

The Jarque–Bera test of normality assumes a null hypothesis that the errors follow a normal distribution. The Jarque–Bera statistic is calculated based on two shape coefficients (Skewness and Kurtosis) that measure asymmetry and flatness, forming the foundation for most normality tests

Table A9. Result of Jarque–Bera test.

Stats	ES	EF	EG
Jarque–Bera statistic	114.529	317.12	217.12
p-value	0.0832	0.0694	0.0584

The probability values are generally higher than 5%, leading us to accept the null hypothesis of the Jarque–Bera test, which states that the errors follow a normal distribution.

- **Homoscedasticity Test (Error Variance Stability)**

Table A10. Result of homoscedasticity test.

Stats	EF	ES	EG
Valeur (LM[4]) value	11163	13061	8921.10
p-value	(0.1270)	(0.1305)	(≈0)
(CD[5]) value	3.0582	2.9411	1.4281
p-value	(0.222)	(0.3207)	(≈0)

According to the results in the table above, Pesaran's CD and Breusch–Pagan's LM tests, which are used to assess sequential dependence among individuals, show critical probabilities significantly higher than 5% for the social and financial efficiency models. This leads us to accept the hypothesis of no sequential dependence. However, for the overall efficiency model, both tests have *p*-values of less than 5%, indicating the presence of sequential dependence. Therefore, the estimates of this model may be biased.

Notes

[1] Klimberg et al. (2009). Using regression and a data envelopment analysis (DEA) to forecast bank performance over time. In *Financial modeling applications and data envelopment applications* (pp. 133–42). Emerald Group Publishing Limited.

[2] All estimates were made using the R software package-deaR- version 1.2.1.

[3] Most of the data in our sample come from the MIXMARKET database (https://databank.worldbank.org/source/mix-market, accessed on 1 January 2019), which is considered the most reliable source of information on microfinance institutions at an international level. These data have been supplemented with macroeconomic variables from the relevant countries, which we collected from the World Bank website (https://databank.worldbank.org, accessed on 1 January 2019).

[4] LM: the *Lagrange multiplier.*

[5] CD: *cross-sectional dependence.*

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