

RESEARCH ARTICLE

Gender diversity and profit efficiency of microfinance institutions: A Sub-Saharan study

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Abstract

Irrespective of the promising opportunity to improve profit efficiency by at least 73%, microfinance institutions operating in Sub-Saharan Africa are efficient only for 27%, far below the average value. The conclusion is drawn after analyzing the profit efficiency of the microfinance institutions using the stochastic frontier approach applied to data obtained from 128 microfinance institutions operating in 34 Sub-Saharan African countries. The study results suggest the presence of uniform profit efficiency experience across time among microfinance institutions. Microfinance institutions operating in low-income countries and credit union form microfinance are economically more efficient than their counterparts. Furthermore, the profit efficiency of microfinance institutions is significantly affected by total assets, cost per loan, loan per staff, legal status, and the county's income group of microfinance. Notably, the profit efficiency of microfinance institutions is adversely affected by the presence of female borrowers and female loan officers suggesting that gender diversity plays a role in the efficiency of microfinance institutions. Finally, we recommend that the managing body of microfinance work more on improving labor efficiency, earning asset utilization, loan collection efficiency, women's involvement and the hottest technology implementation.

Introduction

Microfinance institutions (MFIs) are vibrant tools for fighting poverty by reaching low-income people and disadvantaged groups such as women by creating affordable and easily accessible financial services. In addition, MFIs play remarkable roles in economic growth by providing services to rural people, reducing transaction costs, easing loan requirements (collateral), smoothing consumption, ensuring gender equality, and lending to small-scale borrowers [1–4]. The roles are more helpful and fruitful in the SSA region than in other parts of the world since the region is occupied by the least banked households and the highest number of low-income people [5]. The good news is that approximately 917 MFIs are currently operating in the SSA region [6].

Furthermore, MFIs have dual missions to achieve in their operations. In the social mission, MFIs are designed to provide cheaper financial services to low-income people, women, and

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those excluded from mainstream financial institutions. In the economic mission, they are expected to generate profit from their operations to maintain a sustainable and stable financial position [2,7]. However, the efficiency of MFIs is a prerequisite to achieving these missions [8]. Improving efficiency by working on profit maximization is an expressway for MFIs to reach their goals. Hence, scholars working inside and outside Africa are urging MFIs operating on the continent to focus on improving their technical efficiency [9], labor productivity [8,10], wise utilization of resources and increasing output [11].

In addition, [11] concluded that MFIs in Sub-Saharan Africa (SSA) are unable to reach people in need of financial services due to inefficiency and multidimensional challenges encountered them in operations. According to [12], MFIs operating in Ghana are observing high regulation costs that adversely affect the outreach of the institutions, and more than half of the MFIs in Africa show a reduction in productivity [2] due to high financial leverage, underinvestment, high financing and labor costs [10]. A study focused on transparency matters of MFIs in SSA [13] highlights the existence of low and highly variable transparency among financial institutions.

Despite the above facts, very few studies have been conducted to investigate the profit efficiency of MFIs operating in SSA, and the empirical gaps are remarkable. Empirical studies in the literature are limited in applying stochastic frontier analysis (SFA)—the parametric approach—[2,11,14], covering a large number of MFIs [4] and assessing the roles of gender diversity in the profit efficiency of MFIs. For instance, a recent study assessed the effect of women's participation on the cost efficiency of MFIs in Sub-Saharan Africa fails to address the profit efficiency aspects of the institutions [15]. Unlike our study, the empirical works of [16–19] focused on addressing the effects of gender diversity on financial performance, social performance and technical efficiency of MFIs in Sub-Saharan Africa. Rather our study emphasized the effects of gender diversity on the profit efficiency of the institutions.

This study contributes to the existing stock of knowledge in three main ways. First, it investigates the profit efficiency of MFIs in SSA from the gender diversity perspectives of borrowing services, board members, management members, loan officers and normal personnel. In this study, the effect of gender diversity on the profit efficiency of MFIs is analyzed from five dimensions of women's engagements. Second, it enhances the generalizability of the study findings by considering a large number of MFIs operating in all SSA countries for longer periods (2009–2018). Finally, it applies an advanced econometric model, i.e., stochastic frontier analysis (SFA).

The study results reveal that firm-specific factors and gender diversity determine the profit efficiency of MFIs. Specifically, the profit efficiency of MFIs in SSA is determined by the firm size, female borrowers, female loan officers, cost per loan, loan per staff, legal status, and the county's income group. The institutions are characterized by implementing expensive procedures to produce a loan, using an inefficient labor force and artificial gender diversity in operations.

Theoretical and empirical literature review

Profit efficiency represents the ability of a firm to generate optimal profit using essential economic resources in an efficient manner. It measures the distance between a given firm and the best-practiced firm in profit maximization by taking the combination of cost and revenue efficiency into consideration [20]. The profit efficiency of MFIs refers to the maximum profit that a microfinance institution could earn from performing its day-to-day operations.

Theories in efficiency are derived from the concept of optimal utilization of potential resources by a firm possessing the resources. Firms are inefficient when they are not in the

optimum position of using internal resources: labor, capital and information [21]. Different theoretical perspectives are presented in the literature to explain factors contributing to the efficiency or inefficiency of firms. In this study, the theoretical review is presented from the viewpoint of profit efficiency and its determinants; in particular, it focuses on the roles of gender diversity in profit efficiency.

Resource dependency theory and the resource-based view are the frequently mentioned perspectives in the literature regarding the capability of entities to align potential resources with boosting financial performance and efficiency. A basic assumption of resource dependency theory is that self-capability in matching external environmental resources with a firm's decisions and actions enables a firm to improve its financial performance and efficiency [22,23]. The perspective of the resource-based view is derived from the concept of the efficiency and effectiveness of firms in creating sustainable competitive advantage by developing internal resources and capabilities within the firm as well as the optimal use of resources [24].

The board of directors is vested with the power to provide critical resources that meaningfully serve its entity [22]. In other words, the board of directors and the staff of the firm carry out the responsibility of ensuring the successful integration of critical resources and building capabilities inside a firm. Consistent with these perspectives, the attributes (gender diversity, age, educational level and work experience) of the board of directors and the staff determine the actions and decisions taken by a firm and have a notable effect on the profit efficiency of the firm [22,24–26].

In addition, agency theory has been applied in recent empirical studies to define the role of gender diversity in firm efficiency. Agency theory reflects the presence of potential conflicts of interest between shareholders (principal) and management (agent) that arise from the separation of ownership and control of a firm's operations. As one part of corporate governance, diversity in the board of directors and employees reduces the agency problem that may encounter many entities. Consistent with agency theory, [27] suggested the presence of a positive relationship between board gender diversity and firm financial performance. Likewise, a study conducted in China confirmed that female directors improve the investment efficiency of private firms by reducing agency problems and creating disciplined management staff [28]. From an African perspective, [22] stated that board gender diversity enhances the social performance of microfinance institutions by improving board monitoring and lowering cost per borrower and operating costs.

The thoughts of the aforementioned theories are reversed when the view of social identity theory is observed in firms. Social identity theory suggests that individuals may use age and gender as attributes to create their personal category (in-group) and other social groups (out-group) with the desire to either share or deny existing facts [29]. The summarized literature in the study of [30] realized that social categorization maximizes the difference between in-group and out-group and that such social arrangements erode group cohesion, smooth communication and cooperation in organizations. The authors predicted the existence of a negative linear relationship between board gender diversity and firm performance, consistent with the perspective of social identity theory.

On the other hand, existing empirical studies argue that most MFIs operating in SSA countries are technically, socially and economically inefficient [4,8,9,11]. Scholars have suggested the presence of internal and external causes for the outcomes. According to [4], institution age, outreach, productivity and cost per borrower play significant roles in determining the efficiency of MFIs. Likewise, [8,31] stated that MFIs with higher operating expenses, costs per loan and female borrowers are less efficient. In contrast, [14] argues that providing financial services to women and disadvantaged people makes MFIs financially more profitable and sustainable. Furthermore, [11] has suggested that portfolio risk, total assets, return on assets, operational self-sufficiency and yield on gross portfolios are significant determinants of the overall efficiency of MFIs.

Similar study findings do exist for MFIs operating beyond SSA. The study results of [32] reveal that older and larger MFIs are financially more efficient than their counterparts. According to the study findings of [33], the efficiency of MFI varies based on the regulatory environment, operating region and legal status of the institution.

From gender diversity perspectives, several research findings argue that the contributions of women behind every success are tremendous. For instance, [34] confirmed that women's involvement in research and development teams highly promotes innovation efficiency by providing both informational and social benefits. In their study, [26,35] stated that gender diversity and firm performance are positively interrelated. A study that investigated the association between female leadership and financial performance in MFIs confirmed that the presence of female executives in management and the board significantly improves the financial performance of microfinance institutions [36].

Regarding the efficiency of MFIs, [37] has suggested that female loan officers are key players in enhancing the financial efficiency of MFIs, and [25] has confirmed the presence of a positive association between gender diversity and the social efficiency of MFIs. Despite the wider roles of women in MFIs, empirical studies in SSA are limited in investigating the association between women's roles and the profit efficiency of microfinance institutions. According to [6], women in MFIs act as a client in borrowing services and as a servant for engagement on board members, management members, loan officers and normal personnel.

This study aims to assess the association between women's roles and the profit efficiency of MFIs in SSA from five aspects of gender diversity. Moreover, the study findings contribute to the literature in two other ways. First, it enhances the generalizability of the study findings by taking a large number of MFIs operating in all SSA countries for a longer period (2009–2018). Second, it applies a parametric panel data analysis technique, i.e., the stochastic frontier approach (SFA), unlike those studies that adopted nonparametric data analysis approaches in the MFI literature.

Material and methods

Sampling and data source

The main aim of this study is to investigate the profit efficiencies of MFIs existing in SSA countries. All MFIs operating in the SSA region and have been presented their annual financial report to the global microfinance information exchange (MIX–market) database–regulated under the World Bank Group–for at least five concurrent fiscal years from 2009–2018 were considered in this study. Those MFIs that did not present annual reports to the MIX market database for at least five consecutive fiscal years were excluded from this study. In line with this, secondary data were extracted from the updated webpage of the MIX market database for 128 MFIs operating in 34 Sub-Saharan Africa (SSA) countries. Consequently, we are able to obtain an unbalanced panel data set for 930 observations.

Variable definition & measurement

The variables used in this study were grouped as dependent variables (total profit), input price, output value, and firm- and country-specific factors. The detailed definition and measurement for each variable are presented in [Table 1](#) with essential remarks.

Model specification

To examine the profit efficiencies of MFIs, the stochastic frontier approach (SFA) was followed in this study based on the stochastic model proposed by [41] and used in [20]. The stochastic

Table 1. Variable definition & measurement.

Panel A: Dependent variable		
	Measurement	Definition
π : total profit	Total income–total cost [20]	Net income before tax & donation = Total revenue less total expenses during a given period, including operating and nonoperating. Tax expense and donation income are not considered in the calculation [6].
Panel B: Independent variables		
Input prices		
Labor: Price of labor	Personnel expenses divided by total number of personnel [6].	Cost paid as a salary or wage to mobilize employees' effort
Fund: Price of fund	*Interest expenses (interest paid) divided by total deposits and borrowings [6].	*Interest expense = interest expense on deposits + interest expense on borrowings
PPC: Price of physical capital	*Operating expense divided by net fixed assets**	*Operating expense includes expenses not related to personnel expenses, depreciation, amortization and administrative expenses & **Net fixed assets are tangible assets net of accumulated depreciation [6].
Output quantities		
Loan: Net loan portfolio	Value of loan portfolio net of impairment loss allowance and unearned income and discount (when applicable) [6].	Describes efficiency of MFI in minimizing adverse outcomes
OEA: Other earning Assets	Total of all other assets	Includes receivables, long-term investment, inventories, intangible assets [6].
Panel C: Determinants of inefficiency/efficiency		
Firm-specific variables		
Infirmsize: Firm size	Natural logarithm of total assets [20].	Total assets [6].
ROA: Profitability	ROA [8,20].	Return on asset [6]
Cost: Cost per loan	Operating expense/avg. number of loan	Productivity and efficiency [6].
Loan: Loan per staff	Number of loan outstanding/number of staff	Productivity and efficiency [6]
Boardg: Broad gender diversity	Percent of female as board members [6,38]	Gender diversity in corporate governance
Mgmtg: Management gender diversity	Percent of female in management [6,38]	
Femaleb: Female borrower	Percent of female as active borrowers [6–8]	Efficiency in outreach (depth of outreach)
Panel D: Controlling and additional variables		
Time trend in year (T)	Labeled as "1" if 2009, "2" if 2010, "3" if 2011 . . . and "10" if 2018.	Added as dummy variable
Income: Income category	1 = Upper middle income 2 = Low middle income 3 = Low income	MFI's country income category (dummy variable) [39]
Type: Type of MFIs	1 = NBFi, 2 = Bank, 3 = NGO, 4 = Credit union/cooperative [40]	Legal status of MFI [6]

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frontier approach is a parametric approach that allows researchers to analyze panel data for stochastic production where the disturbance terms, a mixture of an inefficiency term and the idiosyncratic error, are diagnosed separately. Using SFA rather than nonparametric approaches (such as Data Envelopment Analysis (DEA)) has remarkable advantages because it allows efficient estimation of efficiency levels by separating inefficiency from other stochastic shocks and introducing country- or firm-specific controlling variables into the stochastic frontier model [20]. In proposing a stochastic frontier model, [41] assumed that the output deviates from the optimal frontier line as a result of the natural disturbance error (random shocks) and actual inefficiency in accomplishing activities. Thus, stochastic frontier models allow us to

estimate the efficiency of a particular firm separately by controlling for random shocks and inefficiency levels.

Subsequently, the translog profit function was applied in estimating the profit (π) efficiency of MFIs because it has the advantage of presenting in more flexible functional form. The translog stochastic profit function was introduced after the following adjustments were made. First, to avoid an invalid outcome of the logarithm function for negative numbers, profit (π)-dependent variable-is transformed as $\ln(\pi + \theta + 1)$, where θ equals the minimum profit amount of MFI in absolute value term, and MFI incurred maximum loss (earned minimum profit) from the overall sample will have zero profit after transformation, i.e., $\ln(1) = 0$.

Second, the composite error (ϵ_{ijt}) equals $v_{ijt} - u_{ijt}$ for the profit function. Third, the profit efficiency (π_{it}) score is defined by $\pi_{it} = \exp(-u_{it})$ with values between zero and one—a value closer to one indicates more profit efficiency [20]. Fourth, the alternative profit function approach was followed in this study in the output quantity selection procedure since the presence of valid data for the output price is very rare in the study area. Finally, a linear homogeneity assumption is imposed on the input prices of labor and funds as well as the total profit by normalizing them in terms of the price of physical capital before taking their logarithms [20,42]. By considering these specifications, the following profit efficiency frontier model was introduced.

$$\pi_{ijt} = f(z_{ijt}) + \epsilon_{ijt} \tag{1}$$

$$\epsilon_{ijt} = v_{ijt} - u_{ijt} \tag{2}$$

In the stochastic frontier model of [41], the profit function of MFI, operating in specific country j across time period t is defined in terms of the explanatory variables (z_{ijt}) and the disturbance term (ϵ_{ijt}). The disturbance term is further divided into a random shock (v_{ijt}) and an actual inefficiency term (u_{ijt}). Eq 3 presents the translog stochastic profit function, and a detailed description and measurement for each variable used are presented in Table 1.

$$\begin{aligned} \ln\left(\frac{\pi}{PPC}\right)_{ijt} &= \alpha_0 + \alpha_1 \ln\left(\frac{Labor}{PPC}\right)_{ijt} + \alpha_2 \ln\left(\frac{Fund}{PPC}\right)_{ijt} + \alpha_3 \ln(Loan)_{ijt} + \alpha_4 \ln(OEA)_{ijt} \\ &+ \alpha_5 \frac{1}{2} \left[\ln\left(\frac{Labor}{PPC}\right)_{ijt} \right]^2 + \alpha_6 \frac{1}{2} \left[\ln\left(\frac{Fund}{PPC}\right)_{ijt} \right]^2 + \alpha_7 \frac{1}{2} [\ln Loan]_{ijt}^2 + \alpha_8 \frac{1}{2} [\ln OEA]_{ijt}^2 \\ &+ \alpha_9 \ln\left(\frac{Labor}{PPC}\right)_{ijt} * \ln\left(\frac{Fund}{PPC}\right)_{ijt} + \alpha_{10} \ln\left(\frac{Labor}{PPC}\right)_{ijt} * \ln(Loan)_{ijt} \\ &+ \alpha_{11} \ln\left(\frac{Labor}{PPC}\right)_{ijt} * \ln(OEA)_{ijt} + \alpha_{12} \ln\left(\frac{Fund}{PPC}\right)_{ijt} * \ln(Loan)_{ijt} \\ &+ \alpha_{13} \ln\left(\frac{Fund}{PPC}\right)_{ijt} * \ln(OEA)_{ijt} + \alpha_{14} \ln(Loan)_{ijt} * \ln(OEA)_{ijt} \\ &+ \alpha_{15} \ln\left(\frac{Labor}{PPC}\right)_{ijt} * T + \alpha_{16} \ln\left(\frac{Fund}{PPC}\right)_{ijt} * T + \alpha_{17} \ln(Loan)_{ijt} * T \\ &+ \alpha_{18} \ln(OEA)_{ijt} * T + \alpha_{19} T + \frac{1}{2} \alpha_{20} T^2 + u_{ijt} \\ &- v_{ijt} \end{aligned} \tag{3}$$

The stochastic frontier approach assumes that total profit deviates from the targeted profit as a result of a random disturbance term v_{ijt} and the inefficiency term u_{ijt} [41].

The v_{ijt} represents a truncated random error due to measurement error from explanatory variables and is assumed to be independent and identically distributed from u_{ijt} with $N(0, \sigma_v^2)$. u_{ijt} represents the nonnegative random variable estimates inefficient effect and is assumed to follow an asymmetric half normal distribution in which both the mean u and variance σ_u^2 are varied. Furthermore, parametrization techniques suggested by [41] and used in [20] for σ_v^2 and σ_u^2 are applied in this study; these are $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$.

According to [41], a one-step stochastic frontier model can be used to identify predictors of the efficiency of a firm. The stochastic frontier approach uses the maximum likelihood estimation technique to predict parameters included in the frontier model. In this study, the following alternative model is formulated to assess determinants of profit efficiency of MFIs after estimating efficiency scores through translog stochastic profit function.

$$\begin{aligned} u_{ijt} = & \beta_0 + \beta_1 \ln \text{firmsize}_{ijt} + \beta_2 \ln \text{ROA}_{ijt} + \beta_3 \ln \text{cost}_{ijt} + \beta_4 \ln \text{loan}_{ijt} + \beta_5 \text{Boardg}_{ijt} \\ & + \beta_6 \text{Mgmtg}_{ijt} + \beta_7 \ln \text{Femalestaff}_{ijt} + \beta_8 \text{Femaleof}_{ijt} + \beta_9 \text{Femalebr}_{ijt} \\ & + \beta_{10-12} \text{Type}_{ijt} + \beta_{13-14} \text{income}_{ijt} + z_{ijt} \end{aligned} \quad (4)$$

where \ln is the natural logarithm function, firmsize is total assets of MFI, ROA is the return on assets, Boardg is board gender diversity in %; Mgmtg is management gender diversity in %, femalestaff is the number of normal female personnel and Femalebr is the proportion of women borrowers in %. Cost is the cost incurred per loan; loan is the number of loans produced by each staff member; Type is the legal status of MFI, income is the country's income group and z_{ijt} is the disturbance term in the estimation of profit efficiency determinants.

Results and discussion

Attributes of profit efficiency of MFIs in SSA

The stochastic frontier approach was employed to assess the attributes and determinants of profit efficiency of MFIs operating in SSA using ten-year panel data from 2009–2018. To maintain the coherence of idea flow, the discussion begins in this section by being classified into two main sections. The first section presents the basic attributes of profit efficiency, and the second section summarizes the factors affecting the profit efficiency of MFIs in SSA countries. Analysis regarding attributes of profit efficiency of MFIs in SSA was made based on evidence presented in Table 2. The overall profit efficiency of MFIs in SSA was 27% on average, and the score reveals the existence of a tremendous vacuum for further improvement in profit efficiency. In other words, MFI operating in SSA has a great opportunity to enhance its profit efficiency by at least 73%.

Even though there was no marked difference in profit efficiency score among other types of MFIs, the credit union form of MFIs was more efficient in generating profit (35%), whereas nonbank microfinance institutions (NBFIs) were less efficient (23.5%) on average value. MFIs operating in lower middle-income (25%) and low-income (29%) countries are more efficient in generating profit than those operating in upper-middle income countries (21%), on average.

Regarding the time trend, the profit efficiency of the institutions runs between 25% and 27% on average. The trend reveals the presence of uniform profit efficiency experience over the study period. In another expression, there is no adequate effort from MFIs dedicated to improving profit efficiency from time to time in line with existing technical and technological advancement, regardless of the existing space for further improvement of at least 73%. These findings are consistent with the study of [4,5] but contradict the findings of [8,40].

Table 2. Summary statistics for profit efficiency scores.

<i>Panel A: Types of MFI</i>	Profit efficiency scores (%)	
	Mean	Std.Dev.
NBFI	23.50	0.077
Bank	26.33	0.120
NGO	25.90	0.129
Credit union/cooperative	34.90	0.131
Overall efficiency	27.00	0.122
<i>Panel B: Income category of MFI's country</i>		
Upper-middle income	21.45	0.093
Lower-middle income	25.44	0.119
Low income	29.29	0.123
Overall efficiency	27.00	0.122
<i>Panel C: Time trend (2009–2018)</i>		
2009	27.43	0.139
2010	27.13	0.135
2011	27.58	0.135
2012	27.62	0.125
2013	27.46	0.133
2014	26.70	0.122
2015	26.56	0.109
2016	26.56	0.103
2017	26.20	0.104
2018	25.94	0.095
Overall efficiency	27.00	0.122

Source: Authors' computation.

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Furthermore, the frontier model results presented in Table 3 show the presence of meaningful statistical relationships among input prices, output quantity, and the profit efficiency of MFIs. The profit frontier model is statistically significant and acceptable for analysis for three reasons (see Table 3). First, the chi-square test of zero coefficient variation in a model was rejected at a 1% significance level ($\chi^2 = 718.29$), which implies that the explanatory variables used have significantly explained the existing variations in the model and that the parameter coefficients are significantly different from zero. Second, the value of sigma-squared ($\sigma^2 = 8.504$) was significant at a 1% significance level, implying that the estimate of parameters is highly significant. Third, the estimated values of Gamma ($\gamma = 0.6414$) in the model were also highly significant at a 1% significance level, which implies that a significant amount of variation is derived from the inefficiency of the MFIs, while variance due to random error is small.

The estimated parameter for input prices and output quantities shows the existence of an insignificant linear relationship between labor price, loan, and profit efficiency. However, the effect of input price for funds was positive ($\alpha_3 = 18.792$) and highly significant at a 1% significance level, whereas the effect of other earning assets ($\alpha_4 = -0.244$) was negative and significant at a 5% significance level. These results have important implications regarding interest expense management and the balance sheet (asset) utilization capability of financial institutions. First, effective management of cost paid for a fund in the form of interest expense enhances profit efficiency of the MFIs. Second, a portion of the inefficiency of the MFIs is sourced from underutilization of assets on hands, specifically; other earning assets existing

Table 3. Stochastic frontier regression results.

Dependent variable–Total Profit		Profit efficiency	
Panel A: Input, Outputs and Cross terms			
Notation	Parameter	Coef.	t value
ln(Labor/PPC)	α_1	-0.002	-0.01
ln(Fund/PPC)	α_2	18.792	2.60***
ln(Loan)	α_3	0.136	0.99
ln(OEA)	α_4	-0.244	-2.11**
$\frac{1}{2}$ ln(Labor/PPC) ²	α_5	0.137	12.94***
$\frac{1}{2}$ ln(Fund/PPC) ²	α_6	-11.834	-1.42
$\frac{1}{2}$ ln(Loan) ²	α_7	-0.005	-1.11
$\frac{1}{2}$ ln(OEA) ²	α_8	0.004	0.62
ln(Labor/PPC)*ln(Fund/PPC)	α_9	-2.798	-7.11***
ln(Labor/PPC)*ln(Loan)	α_{10}	-0.029	-1.91*
ln(Labor/PPC)*ln(OEA)	α_{11}	0.004	0.40
ln(Fund/PPC)*ln(Loan)	α_{12}	-0.216	-0.41
ln(Fund/PPC)*ln(OEA)	α_{13}	0.701	2.21**
ln(Loan)*ln(OEA)	α_{14}	0.011	1.40
ln(Labor/PPC)*T	α_{15}	0.009	1.74*
ln(Fund/PPC)*T	α_{16}	0.407	2.27**
ln(Loan)*T	α_{17}	-0.006	-1.21
ln(OEA)*T	α_{18}	-0.003	-0.73
$\frac{1}{2}$ (T) ²	α_{19}	0.01	2.57**
T	α_{20}	-0.027	-0.40
Constant	α_0	16.512	9.47***
Wald Chi-square		718.29	0.000***
Sigma squared		0.4159	8.504***
Gamma (γ)		0.6414	14.356***
Log-likelihood function		-611.231	
Number of observation		930	
Number of group		128	

*** p<1%,

** p<5%,

* p<10%.

Source: Authors' stochastic regression outputs.

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with the institutions were not producing adequate profit to the level they are expected to produce rather exposing them to other expenses due to nonperforming loans and depreciation.

Moreover, multiplicative input and output terms have both negative (refer to the coefficient of α_9 and α_{10}) and positive (refer to the coefficient of α_{13}) significant impacts on profit efficiency, implying the existence of spaces for further improvement. The effects of labor and fund price become significant over time. The profit efficiency of MFIs in SSA improves over time as institutions' work experience increases in the effective utilization of labor and funds, and there is a quadratic relationship between the time trend and profit efficiency.

Profit efficiency determinants

In this section, determinants of profit efficiency of MFIs in SSA are discussed based on regression outputs presented in Table 4. Three different empirical modes are developed to

Table 4. Factor affecting profit efficiency of MFIs in SSA.

Dependent variable: Profit Efficiency		Model 1		Model 2		Model 3	
Independent variable	Parameter	Coef	t value	Coef	t value	Coef	t value
Lnfirmsize	β_1	0.007	3.09***	0.011	5.35***		
lnROA	β_2	0.012	1.38	0.008	0.92		
Lncost	β_3	-0.033	-7.32***	-0.033	-7.07***		
Lnloan	β_4	-0.029	-4.83***	-0.031	-5.14***		
Lower_middle_income	β_{10}	0.009	0.32	0.038	1.29		
Low_income	β_{10}	0.043	1.45	0.068	2.29**		
NBFI	β_{11}	-0.109	-10.15***	-0.113	-10.34***		
Bank	β_{11}	-0.071	-5.75***	-0.073	-5.83***		
NGO	β_{11}	-0.066	-6.01***	-0.083	-7.69***		
Boardg	β_5	0.002	0.15			-0.010	-0.60
Mgmtg	β_6	-0.001	-0.08			0.002	0.13
Femalebr	β_7	-0.070	-4.31***			-0.088	-5.59***
lnFemalestaff	β_8	0.006	2.49**			0.003	1.44
Femaleof	β_9	-0.073	-4.20***			-0.050	-2.71***
Constant	β_0	0.480	5.36***	0.385	4.88***	0.326	8.08***
	Number of obs.	930		930		930	
	Chi-square	274.91***		214.410***		53.079***	
	Log likelihood function	757.38		733.42		662.76	

*** p<1%,

** p<5%,

* p<10%.

Source: Authors' stochastic regression outputs.

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understand the impacts of firm-specific factors and gender diversity on the profit efficiency of MFIs. The first model reveals the combined effects of firm-specific factors and gender diversity on the profit efficiency of MFIs. The second model presents the impacts of firm-specific factors, and the third model shows the separate outcomes for gender diversity in relation to profit efficiency. In other words, the determinants are identified after regressing firm size, ROA, board gender diversity, management gender diversity, female borrowers, female staff, cost of the loan, loan per staff, type of MFI, and country-specific factor (income group) on profit efficiency. The results are obtained from the corresponding frontier function through maximum log-likelihood estimation.

The parameters of the chi-square test and log likelihood function confirm the significance of all models in explaining the existing variations, and the coefficients of all parameters are different from zero at a 1% significance level. Moreover, except for the low-income group and female staff, the effects of other explanatory variables remain consistent across all models, confirming the robustness of the study findings. Thus, it is acceptable to use the estimated parameters in explaining determinants of MFI profit efficiency. The explanation is presented in this section.

Regarding firm-specific determinants, the study results reveal the presence of a significant and positive association between total assets (firm size) and profit efficiency. The association is highly significant at the 1% significance level. The profit efficiency of MFIs increases as the total assets of the institution increase. Thus, efficient utilization of economic resources (assets) enhances the profit efficiency of MFIs operating in SSA.

As expected, the effects of cost per loan and loan per staff were negative and statistically significant at a 1% significance level. Cost per loan and loan per staff are deteriorating the profit efficiency of MFIs in SSA. The findings have two remarkable implications. First, microfinance institutions in SSA are exercising the costly practice of producing a loan that harms the profitability of the institutions. Second, staff engaged in producing loans are not generating adequate loans to the expected level. As a result, labor forces running microfinance are not productive on one side and expensive on the other side. In general, MFIs in SSA are producing loans at a cost greater than they will incur, and the existing staff are producing loans below the expected level. This result partially confirms the finding of [8].

Furthermore, the type of MFI and its country income group significantly determine the profit efficiency of MFIs in SSA. The credit union (cooperative) form of MFIs significantly earns more positive profit than other forms of MFIs, and those operating in low-income countries were more efficient in earning profit than those operating in other income groups. In line with the studies of [33,40], the legal status of MFIs and the country's income group do matter for the profit efficiency of the institutions.

In addition to addressing the impacts of the aforementioned factors, this study aims to investigate the effects of gender diversity on the profit efficiency of MFIs in SSA from five perspectives of gender diversity. The effects are addressed in terms of women engagements on the board member, management, borrowing services, loan officers and regular personnel (refer to model 3). The study results reveal that the presence of women on board members, management and normal staff has no significant effect on the profit efficiency of microfinance institutions; however, female borrowers and loan officers significantly affect profit efficiency.

The mission to reach female borrowers in SSA adversely affects the profit efficiency of MFIs. There is a significant and negative association between the presence of female borrowers and the profit efficiency of institutions. Although the evidence is too weak to generalize, the result confirms the presence of trade-off practices between the profit efficiency of MFIs and financial services provision to women. This study's finding is consistent with the finding of [7,31,43].

However, the justification is different. In their study, [11] suggested that ensuring operational efficiency is a prerequisite for MFIs in SSA to simultaneously achieve their dual missions—reaching the disadvantage group and maintaining financial sustainability. Hence, we argue that the presence of adverse effects between female borrowers and profit efficiency is not only because of serving women in financial services provision. As observed in the above discussion, holding a less productive labor force and costly practices of producing loans fundamentally deteriorate the profit efficiency of MFIs. This implies that MFIs in SSA are not efficient in their operation and provision of borrowing services to customers, including women borrowers. In other words, inefficient borrowing services provision has produced inefficient borrowers that harm the profit efficiency of the MFIs.

In contrast to our expectations and previous empirical findings [37,44], female loan officers do not contribute to the profit efficiency of MFIs operating in SSA. The study finding discloses the presence of a negative and significant association between female loan officers and the profit efficiency of MFIs.

Theoretically, these empirical findings present notable remarks. The adverse effects of borrowers' and loan officers' gender diversity against the profit efficiency of MFIs contradict the concepts of resource dependency theory, resource-based view and agency theory. However, the findings are consistent with the concept of social identity theory. It seems that the institutions serve women in borrowing services and allow them to hold officer positions, probably for the desire to meet regulation requirements for gender diversity at work. As a result, women receiving borrowing services from the institutions and working in the institutions may face

group isolation and ignorance by their counterparts, and the institutions are limited in effectively extracting and using the inherent potential of women in the workplace.

Practically, this implies that women's empowerment and capacity building are not part of the financial service provisions for MFIs in SSA. The institutions provide borrowing services to those women who meet the borrowing requirements in the absence of regular follow-up, counseling and training that capacitate women borrowers and help them repay their loan when it dues. Furthermore, MFIs are not active in empowering women officers. Giving an appointment to women to act as a loan officer may not be adequate to extract the inherent potential of women in decision-making, resource provisions and cost management. It requires effective assistants to build self-confidence and take full responsibility.

Conclusions and managerial implications

MFIs operating in SSA realize profit efficiency below the average, only 27%. It indicates the presence of potential opportunities to raise the current profitability position of MFIs in SSA by improving their efficiency level by 73%. Credit union MFIs and MFIs operating in low-income countries are more efficient in realizing profit efficiency than other forms of MFIs and institutions operating in the upper-middle-income group. A uniform profit efficiency level was recognized by the MFIs in SSA from time to time due to the absence of self-advancement and management in line with the rapid changes in technology, and financial services provision techniques. Input prices such as the labor price and price of a fund and the output item, particularly other earning assets, play significant roles in the profit efficiency of MFIs operating in SSA.

Moreover, firm size, cost per loan, loan per personnel, legal status, and country's income group significantly affect the profit efficiency of MFIs in SSA. Regarding gender diversity, the profit efficiency of microfinance institutions is adversely affected by the presence of female borrowers and female loan officers. It is necessary to work more on improving profit efficiency by designing alternative mechanisms that could enhance labor productivity, reduce loan-related costs, capacitate women borrowers and increase loan collection efficiency.

To improve profit efficiency, MFIs in SAA are expected to undertake the following managerial actions and decisions. First, capacity-building reforms and training designed to enhance labor productivity, ensure effective utilization of assets and reduce loan-operating costs should be implemented. Second, redesign human resources policy and loan provision regulations to ensure women's involvement on the board member, management, personnel and borrowing services enable the MFIs to take advantage of gender diversity in making sound decisions, resource provisions and cost management. Finally, focus on removing work environment practices exposing women to self-categorization and isolation and deteriorating their confidence to take full responsibility in decision-making.

To increase the generalizability of the study findings, future research is recommended to incorporate macroeconomic factors and apply an instrumental variable panel data approach in addition to SFA to rigorously investigate endogeneity problems and assess the consistency of the SFA findings.

Supporting information

S1 File.
(XLSX)

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References

1. Alganesh N., Teshome M., & Kibrom H. (2020). Determinants of Financial Performance of Microfinance Institution in Ethiopia. *Horn of Africa Journal of Business and Economics*, 3(1), 65–77.
2. Azad M. A., Munisamy S., Masum A. K., & Wanke P. (2016). Do African microfinance institutions need efficiency for financial stability and social outreach? *South African Journal of Science*, 1–8. Retrieved from <http://dx.doi.org/10.17159/sajs.2016/20150474>.
3. Melesse S. H. (2019). Financial sustainability and outreach performance of saving and credit cooperatives: The case of Eastern Ethiopia. *Asia Pacific Management Review*, 4, 1–9. Retrieved from <https://doi.org/10.1016/j.apmr.2018.08.001>
4. Oteng-Abayie E. F., Amanor K., & Frimpong J. M. (2011). The Measurement and Determinants of Economic Efficiency of Microfinance Institutions in Ghana: A Stochastic Frontier Approach. *African Review of Economics and Finance*, 2(2), 149–166. Retrieved from <https://www.researchgate.net/publication/263080492>.
5. Glisovic, J., Senayit, M., & Moretto, L. (2012). Microfinance Investment in Sub-Saharan Africa: Turning Opportunities into Reality. Washington, DC: SGAP Brief. <http://hdl.handle.net/10986/9440>.
6. MIX. (2021, 11 5). World Bank Group. 2022, MIX Market: <https://databank.worldbank.org/source/mix-market#>.
7. Gashaw T. A., Borzaga C., & Kindie G. (2014). Cost-Efficiency and Outreach of Microfinance Institutions: Tradeoffs and the Role of Ownership. *Journal of International Development*, 26(6), 923–932. <https://doi.org/10.1002/jid.2981>
8. Abdulai A., & Tewari D. D. (2016). Efficiency of Microfinance Institutions in Sub-Saharan Africa: A Stochastic Frontier Approach. *Ghana Journal of Development Studies*, 13(2), 117–139. <https://doi.org/10.4314/gjds.v13i2.7>
9. Bereket Z. G., & Hailemichael T. G. (2016). Technical efficiency of Microfinance Institutions (MFIs) Does ownership matter? Evidence from African MFIs. *International Journal of Development Issues*, 15(3), 224–239. Retrieved from <http://dx.doi.org/10.1108/IJDI-04-2016-0026>.
10. Towo N., Mori N., & Ishengoma E. (2019). Financial leverage and labor productivity in microfinance cooperatives in Tanzania. *Cogent Business & Management*, 6(1), 1–17. <https://doi.org/10.1080/23311975.2019.1635334>
11. Segun K. R., & Anjugam M. (2013). Measuring the Efficiency of Sub-Saharan Africa's Microfinance Institutions and Its Drivers. *Annals of Public and Cooperative Economics*, 84(4), 399–422.
12. Ayayi A. G., & Peprah J. A. (2018). Cost implications of microfinance regulation: lessons from Ghana. *Journal of Sustainable Finance & Investment*, 1–17. Retrieved from <https://doi.org/10.1080/20430795.2018.1462633>
13. Haileslasie T., Roberts H., & Whiting R. H. (2017). Microfinance institutions' transparency in Sub-Saharan Africa. *Applied Economics*, 1–17. <https://doi.org/10.1080/00036846.2017.1368993>
14. Agostinho E. A., & Gaspar R. M. (2021). Efficiency of Microfinance Institutions: Analysis of Southern African Development Community (SADC) Member Countries. *Journal of Business & Economic Policy*, 8(1), 12–23. <https://doi.org/10.30845/jbep.v8n1p2>
15. Tarekegn T. E., Arega S. A., & Deresse M. L. (2024). Women's participation and cost efficiency in microfinance institutions: a Sub-Saharan study. *Cogent Business & Management*, 11(1), 1–16.
16. Sarpong-Danquah B., Adusei M., & Frimpong J. M. (2023). Effect of board gender diversity on the financial performance of microfinance institutions: Does judicial efficiency matter? *Annals of Public and Cooperative Economics*, 94(2), 495–518.

17. Adalessossi K. (2024). What are the determinants of the financial and social performance of MFIs in Togo? Does gender borrower matter on financial performance? *Finance Research Letters*, 62(A), 1–12.
18. Ali H., Gueyie J.-P., & Chrysostome E. V. (2023). Gender, Credit Risk and Performance in Sub-Saharan African Microfinance Institutions. *Journal of African Business*, 24(2), 235–259.
19. Boadi I., Dziwornu R., & Osarfo D. (2022). Technical efficiency in the Ghanaian banking sector: does boardroom gender diversity matter? *Corporate governance: international journal of business in society*, 22(2022), 1133–1157.
20. Srairi S. A. (2010). Cost and profit efficiency of conventional and Islamic banks in GCC countries. *Journal of Productivity Analysis*, 34, 45–62. <https://doi.org/10.1007/s11123-009-0161-7>
21. Leibenstein H. (1979). X-Efficiency: From Concept to Theory. *Challenge*, 22(4), 13–22. <https://doi.org/10.1080/05775132.1979.11470543>
22. Badu E. A. (2022). Board diversity and performance of microfinance institutions: new insight from Ghana. *EuroMed J. Management*, 4(2), 148–166.
23. Adeabah D., Gyeke-Dako A., & Andoh C. (2019). Board gender diversity, corporate governance and bank efficiency in Ghana: a two stage data envelope analysis (DEA) approach. *E Corporate Governance*, 19(2), 299–320. <https://doi.org/10.1108/CG-08-2017-0171>
24. Arbelo A., Arbelo-Pérez M., & Pérez-Gómez P. (2021). Profit Efficiency as a Measure of Performance and Frontier Models: A Resource-Based View. *Business Research Quarterly*, 143–159. Retrieved from <https://doi.org/10.1177/2340944420924336>
25. Fall F. S., Tchuigoua H. T., Vanhems, & Simar L. (2021). Gender effect on microfinance social efficiency: A robust nonparametric approach. *European Journal of Operational Research*, 1–14. Retrieved from <https://doi.org/10.1016/j.ejor.2021.03.020>
26. Brahma S., Nwafor C., & Boateng A. (2020). Board gender diversity and firm performance: The UK evidence. *International Journal of Finance & Economics*, 1–16. <https://doi.org/10.1002/ijfe.2089>
27. Pidani R. R., Mahmood A., & Agbola F. W. (2020). Does the Board Gender Diversity Enhance Firm Performance? *Asian Journal of Business Research*, 10(1), 29–46. <https://doi.org/10.14707/ajbr.200074>
28. Mirza S. S., Majeed M. A., & Ahsan T. (2020). Board gender diversity, competitive pressure and investment efficiency in Chinese private firms. *Eurasian Business Review*, 10, 417–440. Retrieved from <https://doi.org/10.1007/s40821-019-00138-5>
29. Trepte S., & Loy L. S. (2017). Social Identity Theory and Self-Categorization Theory. *The International Encyclopedia of Media Effects*, 1–13. Retrieved from <https://doi.org/10.1002/9781118783764.wbieme0088>
30. Ali M., Ng Y. L., & Kulik C. T. (2014). Board Age and Gender Diversity: A Test of Competing Linear and Curvilinear Predictions. *J Bus Ethics*, 125, 497–512. <https://doi.org/10.1007/s10551-013-1930-9>
31. Hermes N., Lensink R., & Meesters A. (2011). Outreach and Efficiency of Microfinance Institutions. *World Development*, 39(6), 938–948. <https://doi.org/10.1016/j.worlddev.2009.10.018>
32. Wijesiria M., Yaronb J., & Meoli M. (2017). Assessing the financial and outreach efficiency of microfinance institutions: Do age and size matter? *Journal of Multinational Financial Management*, 63–76. Retrieved from <http://dx.doi.org/10.1016/j.mulfin.2017.05.004>.
33. Nourani M., Malim N. A., & Mia M. A. (2021). Revisiting efficiency of microfinance institutions (MFIs): an application of network data envelopment analysis. *Economic Research-Ekonomska Istraživanja*, 34(1), 1146–1169. <https://doi.org/10.1080/1331677X.2020.1819853>
34. Xiea L., Zhou J., Zong Q., & Lud Q. (2020). Gender diversity in R&D teams and innovation efficiency: Role of the innovation context. *Research Policy*, 1–13. Retrieved from <https://doi.org/10.1016/j.respol.2019.103885>
35. Ali M. (2015). Impact of gender-focused human resource management on performance: The mediating effects of gender diversity. *Australian Journal of Management*, 1–22. <https://doi.org/10.1177/0312896214565119>
36. Strøm R. Ø., D'Espallier B., & Mersland R. (2014). Female leadership, performance, and governance in microfinance institutions. *Journal of Banking & Finance*, 42, 60–75. Retrieved from <http://dx.doi.org/10.1016/j.jbankfin.2014.01.014>.
37. Bibi U., Balli H. O., Matthews C. D., & Tripe D. W. (2017). Impact of gender and governance on microfinance efficiency. *Journal of International Financial Markets, Institutions & Money*, 1–29. Retrieved from <https://doi.org/10.1016/j.intfin.2017.12.008>
38. Mori N., Golesorkhi S., Randø T., & Hermes N. (2015). Board composition and outreach performance of microfinance institutions. *Strategic Change*, 24(1), 99–113. Retrieved from <https://doi.org/10.1002/jsc.2000>

39. World Bank, G. (2022, May 5). World bank. World bank: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.
40. Tilahun A. T. (2021). Do location and legal status matter in microfinance institutions' performance? Evidence from sub-Saharan Africa. *Development in Practice*, 31(3), 404–4020. <https://doi.org/10.1080/09614524.2020.1853060>
41. Battese G. E., & Coelli T. J. (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics*, 20, 325–332.
42. Lu Y. F., Gan C., Hu B., Toh M. Y., & Cohen D. A. (2018). Bank efficiency in New Zealand: a stochastic frontier approach. *New Zealand Economic Papers*, 53(2), 1–19. Retrieved from <https://doi.org/10.1080/00779954.2018.1455728>
43. Churchill S. A. (2018). Sustainability and depth of outreach: Evidence from microfinance institutions in sub-Saharan. *Development Policy Review*, 36(S2), 0676–0695. <https://doi.org/10.1111/dpr.12362>
44. Beck T., Behr P., & Guettler A. (2013). Gender and Banking: Are Women Better Loan Officers? *Review of Finance*, 17, 1279–1321. <https://doi.org/10.1093/rof/rfs028>