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Subsidy Efficiency in Microfinance

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Abstract

The microfinance sector has been growing rapidly in the last couple of years. An important attribution to the rise of these growth rates is the financial support Microfinance Institutions (MFIs) have received from private and public donors. Yearly, more than 1 billion USD of subsidies and donations is being attracted by the microfinance sector, yet research with respect to the effect of these funds on the performance of the MFI is limited. This research uses a Stochastic Frontier Analysis (SFA) to analyse the relationship between the subsidy reliance of a MFI and its cost-efficiency, using panel data of 203 MFIs from 49 different countries within a period of 8 years (2006-2013). It is shown that there is no significant relationship. Other factors such as the control of corruption in a country, the political stability, the average loan size and the percentage of female borrowers, all do have a significant positive effect on MFIs cost-efficiency. These are important findings for public and private policy makers.

1. Introduction

Microfinance is a term used to describe financial services for those without access to traditional banking. These services include loans, savings accounts, money transfer services and insurances and aim at individuals at a certain poverty level. Since the late 1970s, the poor in developing countries have increasingly gained access to such financial services and in 2012 more than 190 million people benefited from microfinance services (OPIC, 2012). The Microfinance market has been growing rapidly, especially since the early 2000s. Average annual growth rates per Microfinance Institution (MFI), measured as the number of clients served, amounted to 50 per cent during 2000-2005. These rates increased even further to 70-100 per cent per year from 2006-2008 (Sinah, 2010).

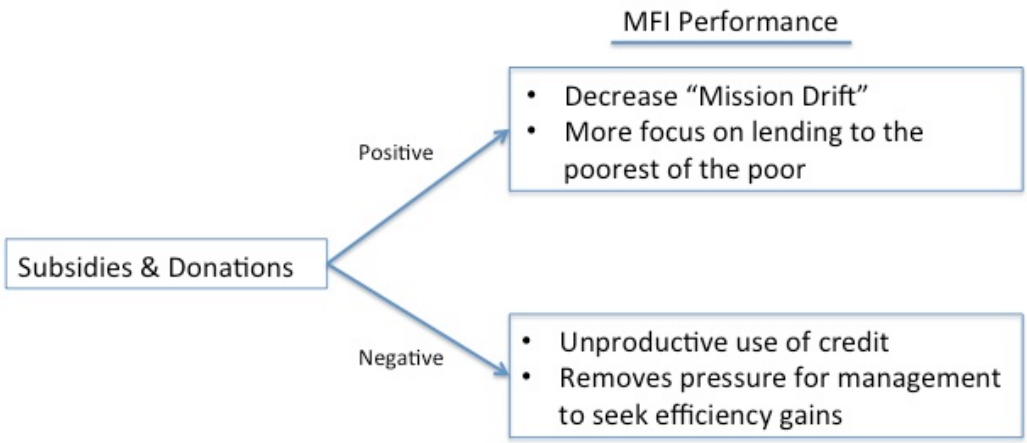
An important attribution to the rise of these growth rates is the financial support MFIs have received from private and public donors. Over the last twenty years, the microfinance sector has attracted over 1 billion USD per year as a subsidy or donation. Although the sector is becoming more and more commercial due to commercial funding, the majority of the MFIs still depend on subsidized funding from donor organizations (Armendariz and Morduch, 2010). In fact, only 5 per cent of all existing MFIs operate independently of subsidized funding from private or public donors (UNCDF, 2005).

An important question is whether these subsidies and donations are helping MFIs to be efficient. Therefore there is an ongoing debate regarding the effectiveness of subsidies on MFIs' performance. On the one hand, there are researchers who claim offering subsidized credit programs at below market interest rates, is a wasteful way of encouraging development as it leads to unproductive use of credit and creates opportunities for corruption. In addition, by subsidizing costs pressure can be removed that would have otherwise pressured management to seek efficiency gains (Armendariz and Morduch, 2010). Furthermore, Dewatripont and Maskin (1995) claim that MFIs that perform poorly and have access to donor money have fewer incentives to minimize their costs.

On the other hand, subsidies and donations could have a positive effect on MFIs performance, and decrease what is called the "mission drift". The main missions of a MFI are to provide financial services to individuals below a certain poverty level, while at the same time being financially sustainable. Yet, the commercialization of the microfinance market might force MFIs to serve richer clients at the expense of the poor. As reaching out to the

poorest of the poor is more risky, commercialized MFIs[1] might be forced by their funders to serve richer clients, who are associated with smaller risks. In other words, it is argued that there is a trade-off between financial and social sustainability. Considerable research has been carried out to prove this "mission drift". For example Mersland and Strom (2009) take the view that the mission drift tends to increase when the MFI seeks higher profitability and when average costs become higher. Cull et al. (2007) however, conclude that MFIs with higher profits are correlated with higher outreach. Yet, larger individual lenders tend to serve richer clients. That is in line with the findings of Hermes et al. (2008) who find evidence for a negative relationship between outreach and efficiency. These findings imply that subsidies and donations are essential for MFIs to focus on their main mission and serve individuals below a certain poverty level.

Figure 1: Possible effectiveness of subsidies and donations on MFI performance



This paper is an important contribution to this discussion, as it analyses the effect of subsidies and donations on MFI performance, using cost-efficiency as a performance measure. A Stochastic Frontier Analysis based on the model suggested by Battese and Coelli (1995) is employed, which simultaneously calculates cost-inefficiency, and estimates the effect of subsidies and donations on cost-inefficiency, using maximum likelihood. Panel data of 203 MFIs from 49 different countries within a period of eight years (2006-2013), from the Microfinance Information Exchange (MIX) database has been used.

The Stochastic Frontier Analysis finds that there is no significant relationship between subsidies and donations and MFIs' cost-efficiency. This is an influential finding for

[1] MFIs that are independent of subsidies and donations
[2] For a more detailed explanation of the Subsidy Dependence Index see Appendix

governments, NGOs and other donators to MFIs. Subsidies and donations do not directly influence the cost-efficiency of a MFI. However, other factors such as the control of corruption in a country, the political stability, the average loan size and the percentage of female borrowers, all do have a significant effect on MFIs cost-efficiency. Subsidies and donations could therefore better be used for regulatory purposes and the attraction of more female borrowers.

The rest of this paper is structured as follows: chapter 2 provides a literature review of scientific researches about the effect of subsidies on different measures of microfinance performance. Chapter 3 specifies the methodology of this research, chapter 4 provides an empirical analysis, which consists of a description of the data and shows the results, chapter 5 concludes and provides a discussion, and chapter 6 and 7 respectively show the bibliography and the appendix.

2. Literature review

In spite of the total amount of development aid to microfinance coming from public sources in 2010 amounting to 14.6 billion USD (D'Espallier et al., 2014), research with respect to the effect of subsidies on MFI performance is limited. The existing literature can be divided into three indicators of MFI performance. Firstly, part of the literature investigated the impact of subsidies on the cost-efficiency of Microfinance Institutions. As this is the performance measure used in this research, this literature review will mainly focus on existing literature analyzing the impact of subsidies and donation of MFI's cost-efficiency. In addition, subsidies' effect on MFI's repayment performance and social performance has been investigated.

2.1 Subsidies' effect on MFIs' cost-efficiency

Two main papers investigate the impact of subsidies on performance, using cost-efficiency as a performance measure. In these papers different approaches to measure cost-efficiency have been employed. The first approach is a cross-sectional OLS-regression performed by Marek Hudon and Daniel Traca (2011), using staff productivity (borrowers per staff) as the cost-efficiency measure. Their results show that subsidies have had a positive impact on cost-efficiency, but only up to a certain subsidy level. Cross-sectional data from 73 different MFIs have been incorporated in the model, resulting in a positive estimation of 0.703 for the

subsidy effect, significant at a 10% significance level. This indicates that for every extra USD donated equity over the total equity, there will be an increase of 0.703 in the logarithm of the amount of borrowers per staff. The square of the subsidy effect has a negative estimated effect on staff productivity of -0.408 (also significant at 10% significance level), implying that subsidization beyond a certain threshold renders the marginal effect on efficiency negatively. Although their findings are significant, there are several remarks that should be made on the approach and model Hudon and Traca (2011) have used. The fact that only staff productivity is used as an efficiency measure limits the strength of their findings. Staff productivity might be a part of cost-efficiency, but it incorporates no form of financial performance of the MFI. In addition, results are based on an estimated model with a R^2 of 0.1, providing no strong evidence for their conclusions. A third concern is possible endogeneity of the MFI's subsidy intensity. It could be that there is reverse causality, meaning that not only subsidy intensity affects staff productivity, but this could also be reversed. When the productivity of a certain MFI is low and its sustainability is threatened, donors have more incentives to support that MFI financially. Endogeneity of the subsidy indicator causes biased estimations, negatively affecting the credibility of the conclusions.

A second approach that uses cost-efficiency as a performance measure, is research performed by Hudon and Nawaz (2011). Their findings show that there is a positive relationship between subsidies and cost-efficiency, but only funds that are used for subsidized borrowings. In order to estimate cost-efficiency a Data Envelopment Analysis (DEA) has been used. Together with the Stochastic Frontier Analysis (SFA) used in this research, these are the two most commonly used approaches to estimate pure efficiency scores. Both methods are similar because they are efficiency frontier analysis and determine a frontier on which inefficiency is based. However, the difference is that DEA is a non-parametric approach that uses mathematical programming to identify the efficient frontier and SFA is a parametric approach and therefore allows controlling for measurement error and luck factors. For the DEA performed by Hudon and Nawaz (2011) input variables used are: total assets, operating costs and the number of staff. Furthermore as output variables the gross loan portfolio, financial revenue and financial revenue minus subsidy have been used. The analysis is based on a two-stage model in which data from 179 MFIs over two years (2005 and 2006) is used. After measuring efficiency using DEA, a Tobit regression analysis was carried out to determine which variables affect efficiency. Instead of using one subsidy measure, a distinction has been made between subsidized equity, subsidized borrowings and

revenue grants. Results show that only subsidized borrowings have a significant positive effect on the cost-efficiency estimated using DEA. Although this effect is small (between 0.077 and 0.093) subsidized borrowings have a significant positive estimation result in all the specifications. This indicates that the purpose of a subsidy or donation is important to determine whether it has a significant effect on MFI's cost-efficiency.

2.2 Subsidies' effect on other performance measures

Other performance measures used in existing literature can be divided into repayment performance measures and social performance measures.

Firstly, Jeffrey L. Callen (1994) and Jonathan Murdoch (2005) base their findings of subsidies' effect on performance on the repayment performance of the MFI. Callen (1994) states that when MFIs are subsidized, this leads to better monitoring of outstanding loans, which improves the repayment performance. Jonathan Morduch (2005) argues that if there is one donor fund subsidizing a specific MFI, this leads to an easier attraction of additional financial resources for this MFI. This is due to the trust it signals in the strength and efficiency of the specific MFI. It should be noted that both the arguments of Callen (1994) and Murdoch (2005) are based on theory and not on empirical research.

Marya I. Pylypiv and Sugato Chakravarty (2013) empirically investigate the effect of subsidies on MFIs' borrower repayment rate. More specifically they research the effect of different types of subsidies and their distinctive effects on repayment rates. A difference is made between private and public subsidized funding and it is concluded that MFIs that have a higher proportion of private donor funds to public subsidies have lower rates of portfolios at risk, fewer delinquent loans and their overall portfolios are less risky. Their conclusions are based upon a simple linear OLS-regression in which the dependent variable is firstly the non-performing loan ratio, and in a second regression the portfolio at risk of more than 30 days. As a subsidy measure Pylypiv and Chakravarty (2013) use a summation of discounted debt, discounted capital and grants. The advantage of this method is that using the repayment rate as dependent variable the problem of reversed causality and therefore endogeneity is circumvented. It is unlikely that MFIs that have a high percentage of portfolios at risk attract more subsidies.

Germaise and Natividad (2013) also empirically investigate the effect of subsidies on MFIs' performance. In contrast to Pylypiv and Chakravarty (2013) they prove that MFIs with higher

levels of subsidization have higher gross margins, but there is no effect on other performance criteria. They also conclude that cheap credit, due to subsidies, has little impact on the total amount of lending, but it leads to a shift of non-commercial loans. These are loans that are used for consumption of the borrower instead of income generating commercial loans to small enterprises. Furthermore, Nawaz (2010) investigated the extent to which the Microfinance sector in 2005 and 2006 depended on subsidies. In order to do so, Nawaz used a measure of subsidies based on Yaron's Subsidy Dependence Index (SDI)[2]. This index is used more often in existing literature and measures what the interest charged to borrowers needs to be in order for the bank to operate without subsidies. More importantly in this research Nawaz also carried out a with- and without subsidy analysis and concludes that MFIs financial performance declines without subsidies. As a measure of financial performance Return On Assets (ROA) was used which is very different from the risk indicators Pylypiv and Chakravarty (2013) have used. However both researches agree with one another on the positive effect of subsidies on MFIs' financial performance.

Secondly, part of the remaining existing literature lays focus on the effect of subsidization on the social performance of Microfinance Institutions. The common finding of these researches is that subsidized MFIs have a higher social performance than unsubsidized MFIs. D'Espallier et al. (2013) provide empirical evidence, that subsidized MFIs focus more on female borrowers and on average have smaller outstanding loans. Small outstanding loans are an indicator of reaching out to the poorest of the poor and are therefore a positive social performance indicator. Nawaz (2010) comes to the same conclusion. In addition to the with- and without subsidy analysis on financial performance, as mentioned above, Nawaz (2010) looked at subsidization and its impact on social performance. An example of a social performance indicator used is whether MFIs provide other services such as education and health care. The results show that subsidized MFIs on average provide more of these services. Furthermore, in accordance with the findings of d'Espallier (2013), Nawaz (2010) provides evidence that subsidized MFIs on average lend to poorer people and to more woman than unsubsidized MFIs. However, all of these conclusions are based on a with- and without subsidy analysis, and therefore do nothing about the extent to which subsidies affect MFIs' efficiency. Neither does it provide evidence that there is a certain turning point from which the percentage or amount of subsidies becomes efficient or vice versa. Germaise and Natividad (2013) however do provide evidence that MFIs that receive higher levels of

[2] For a more detailed explanation of the Subsidy Dependence Index see Appendix

subsidies are associated with higher levels of loans for non-commercial purposes. This means that loans are commonly used for consumption, which makes sense as subsidized MFIs have less incentive to monitor their customers.

In summary, the main findings of existing literature looking at the effects of subsidies on the social performance of a MFI, are that subsidies increase social performance. There are more financial resources for non-financial services such as education and health, and more female borrowers are reached. In addition, more loans are issued and so the outreach is bigger. However it seems that these loans are commonly used for consumption, which is not in line with the initial purpose of Microfinance; providing financial services to the poor in order to stimulate entrepreneurial activity.

To conclude, existing literature on the impact of subsidies on MFI performance is firstly very limited and secondly results are ambiguous. Next to a distinction between the three different focus areas of MFIs' performance, varying methods have been used having their advantages and disadvantages. In addition, these studies never used a Stochastic Frontier Analysis, and mostly data from only two or three years have been incorporated in the model. This research therefore makes a valuable contribution to existing literature using unbalanced panel data from 203 Microfinance Institutions spread over 49 different countries.

3. Methodology

In this research the focus of MFIs' performance is the cost-efficiency, measured using a Stochastic Frontier Analysis (SFA). As mentioned above, in previous research different methods of estimating efficiency have been employed, but the two most commonly used are the Data Envelopment Analysis (DEA) and the Stochastic Frontier Analysis (SFA). In this research SFA is used, as it controls for measurement errors and other random effects. In addition it allows for taking into account several factors that may determine the position of the cost-frontier, next to output levels and input prices. The Stochastic Frontier Analysis is based on two main equations, namely a cost frontier and an inefficiency equation. These are explained in chapter 3.1 and 3.2 respectively.

3.1 The Cost Frontier

For this Stochastic Frontier Analysis, the model suggested by Battese and Coelli (1995) is

used.[3] This model measures cost-inefficiency as the difference between the actual costs of the lending activities of a MFI and what the costs of a best practice MFI would have been under the same conditions and producing the same output. Due to the difficulty to address the exact cost function of a MFI, inefficiencies are measured in comparison to an efficient cost frontier. Thus the costs of a best practice MFI are estimated using a stochastic cost frontier. The following equation shows the specification of this frontier:

$$lnC_{i,t} = C\left(y_{i,t}, w_{i,t}, q_{i,t};\ \beta\right) + \varepsilon_{i,t} \qquad \text{with } \varepsilon_{i,t} = v_{i,t} + u_{i,t} \qquad \textbf{(1)}$$

Here $C_{i,t}$ is the total cost of MFI i at time t and $C\left(y_{i,t}, w_{i,t}, q_{i,t};\ \beta\right)$ the cost frontier. $y_{i,t}$ is the logarithm of the output of MFI i at time t, $w_{i,t}$ is a vector of the logarithm of the input prices of MFI i at time t, $q_{i,t}$ are MFI specific control variables and β is a vector of all parameters to be estimated. In this research input costs are measured as the total expenses per unit of labour and the interest expenses per units of deposits held. Furthermore the output of a MFI is measured as the gross loan portfolio. The parametric form of the cost-function will be presented later in this chapter.

The cost frontier shows the combinations of output levels and the related minimum amount of costs of inputs. It is important to note that there are two assumptions made for $u_{i,t}$ and $v_{i,t}$:

1. $u_{i,t}$ are random variables that capture the cost-inefficiency of MFI i at time t. It is assumed that these variables are non-negative, independent and identically distributed, with a truncated normal distribution: $u_{i,t} \sim N^{+}(m_{i,t}, \sigma_u^2)$[4]. A truncated normal distribution is assumed, because the total costs of a MFI can never be lower than the costs of the efficiency frontier.
2. $v_{i,t}$ represent random errors and captures measurement errors. It is assumed that $v_{i,t}$ is also independent and identically distributed and also independent from $u_{i,t}$: $v_{i,t} \sim iidN(0, \sigma_v^2)$.

In order to find the inefficiency of MFI i at time t, $u_{i,t}$ has to be estimated. The econometric way to estimate cost-inefficiency is explained by the following equation, as equation (1) can be rewritten and cost-inefficiency $u_{i,t}$ can be specified as follows:

[3] STATA is used to estimate this model. In STATA the Battese and Coelli (1995) model is known.
[4] $m_{i,t}$ stands for the first moment of the inefficiency distribution for MFI i at time t. See chapter 3.2.

$$CostInef_{i,t} = \frac{C_{i,t}}{\exp\left(C\left(y_{i,t}, w_{i,t}, q_{i,t};\ \beta\right)\right)} = \frac{\exp\left(C\left(y_{i,t}, w_{i,t}, q_{i,t};\ \beta\right) + u_{i,t}\right)}{\exp\left(C\left(y_{i,t}, w_{i,t}, q_{i,t};\ \beta\right)\right.} = \exp\left(u_{i,t}\right)^{5}$$

Figure 2 graphically shows how inefficiency is measured according to the Stochastic Frontier Analysis.

Figure 2: Graphical explanation of the Stochastic Frontier Analysis

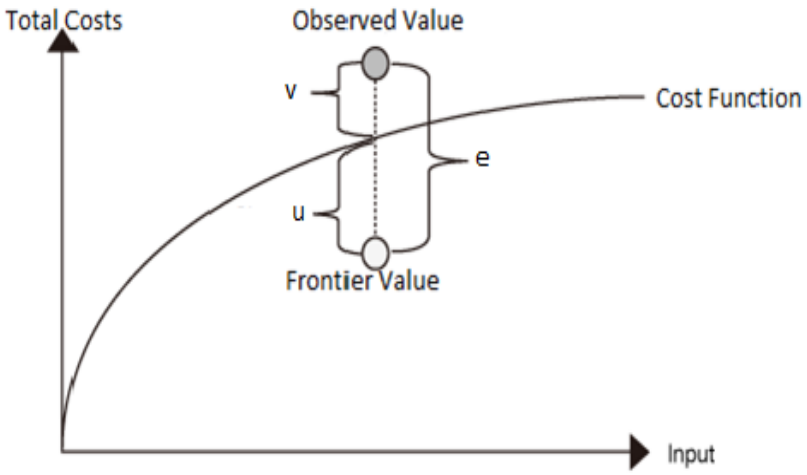


Figure 2 shows that $\varepsilon_{i,t} = v_{i,t} + u_{i,t}$ and inefficiency is measured as the difference between the observed value of costs under the same value of input as compared to the frontier value, ceteris paribus. If a MFI is cost-efficient, it is located somewhere on the frontier, meaning that the MFI minimizes its costs given a certain output.

In order to estimate the stochastic frontier model and render it operational a specification of the cost function is required. The specification of the cost function used for this analysis, is the cost function developed by Sealey and Lindley (1977). Their function is based upon the idea that financial institutions are intermediates between funders and borrowers. It should be noted that the cost function has a translog specification, which means that it allows for maximum flexibility of the shape of the frontier. Next to that it means that it consists of the input and output variables by itself, the square of these variables and the interaction terms between all variables. The specification of the cost function is as follows:

[5] SFA is mostly used measuring technical efficiency. TE = exp(-u). However in this research SFA is used measuring cost-inefficiency.

$$\ln TC_{i,t} =$$
$$\beta_0 + \beta_1 \ln(LABOUR_{i,t}) + \beta_2 \ln(CAPITAL_{i,t}) + \beta_3 \ln(LOANS_{i,t}) + \beta_4 \ln(LABOUR_{i,t})^2 +$$
$$\beta_5 \ln(CAPITAL_{i,t})^2 + \beta_6 \ln(LOANS_{i,t})^2 + \beta_7 \ln(LABOUR_{i,t}) \ln(CAPITAL_{i,t}) +$$
$$\beta_8 \ln(LABOUR_{i,t}) \ln(LOANS_{i,t}) + \beta_9 \ln(CAPITAL_{i,t}) \ln(LOANS_{i,t}) + \sum \beta_m MFITYPE_{i,t} +$$
$$\beta_{16} EQ_{i,t} + v_{i,t} + u_{i,t} \quad \textbf{(2)}$$

As mentioned before, input costs are measured as the total expenses per unit of labour and the interest expenses per units of deposits held. Furthermore the output of a MFI is measured as the gross loan portfolio. Next to the input and output variables a vector of dummies for 6 different types of MFIs are included in the model. This is to control for different types of MFIs having different cost functions. In addition the equity ratio is added to model in order to control for differences in risk taking strategies. The following table shows an overview of the definitions and measurements of all variables used in the cost function of MFI i at time t.

Table 1: Variables of the Cost Frontier

Variable	Definition	Measurement
TC	Total costs of a MFI	$\frac{Total\ expenses}{Total\ assets}$
$LABOUR$	Price of a unit of labour for one year	$\frac{Total\ operating\ expenses}{Total\ amount\ of\ employees}$
$CAPITAL$	Interest expenses per unit of deposits held.	$\frac{Total\ financial\ expenses}{Total\ deposits\ in\ dollars}$
$LOANS$	The gross loan portfolio	Total amount of loans outstanding
$MFITYPE$	Different types of MFIs	A vector of dummies for 6 different types of MFI. Banks, cooperatives, non-bank financial institutions, non-governmental organizations, rural banks and other organizations.
EQ	Equity ratio	$\frac{Equity}{Total\ assets}$

3.2 The Inefficiency Equation

The cost-frontier (1) measures the cost-inefficiency of the included MFIs in the sample at time t. However this research' interest lies in the effect of subsidies on cost-inefficiency.

Therefore in addition, an inefficiency equation is needed. Also following Battese and Coelli (1995) the inefficiency of MFI i at time t is modelled as follows:

$$m_{i,t} = \delta_0 + \delta_1 Z_{i,t} \quad \textbf{(3)}$$

Where $m_{i,t}$ stands for the first moment of the inefficiency distribution of MFI i at time t. The higher $m_{i,t}$ the more inefficient MFI i at time t, given its costs. $Z_{i,t}$ stands for the vector of variables that determine the inefficiency of MFI i at time t. Both equation (1) and (3) are estimated simultaneously using maximum likelihood. The specification of the inefficiency equation is as follows:

$$m_{i,t} = \delta_0 + \delta_1 SUBSIDY_{i,t} + \delta_2 SUBSIDY_{i,t}{}^2 + \delta_{i=3\ldots\ldots18} X_{i,t} \quad \textbf{(4)}$$

As the aim of this research is to investigate the effect of MFIs dependency on subsidies on its performance this is the main model of this research. $SUBSIDY_{i,t}$ is the subsidy indicator which is measured as the percentage of donated equity plus donations over total equity of MFI i at time t. Next to subsidy dependence, a vector of MFI specific control variables ($X_{i,t}$) are added to the model. Table 2 shows the control variables used in equation (4). $LSIZE$, the logarithm of the average loan size per borrower is included to correct for possible economies of scale that influence cost efficiency and is therefore expected to have a negative estimation result. GDP is expected to have a negative effect on $m_{i,t}$ as in richer countries MFIs are expected to be more cost-efficient. $FEMALE$ stands for the percentage of female borrowers over the total amount of borrowers. As mentioned in the literature review, previous research has found a positive relationship between female borrowers and MFIs' efficiency. Therefore the estimation result is expected to be negative. $OUTREACH$ is a dummy variable that controls for the amount of clients a MFI has.[6] It is expected that the smaller the $OUTREACH$ the higher the inefficiency, due to economies of scale. Finally six Kauffman indicators are used as control variables to explain Microfinance Institutions' cost-efficiency. These are worldwide governance indicators that quantify the process by which governments are selected, monitored and replaced. For each of these six indicators it is expected that there is a negative relationship with inefficiency, as the better the regulation of a country is organized the less inefficient MFIs will be.

[6] In the MIX Market database this is indicated as either being Small, Medium or Large.

Table 2: Control variables of the Inefficiency Equation

Variable	Definition	Measurement
$LSIZE$	Average Loan Size per borrower	$LSIZE = \ln\left(\frac{Total\ amount\ loans\ outstanding}{Total\ amount\ of\ borrowers}\right)$
GDP	Gross Domestic Product	$GDP = \text{LGDP}_{i,t}$
$FEMALE$	Percentage of female borrowers	$\frac{Amount\ of\ female\ borrowers}{Total\ amount\ of\ borrowers}$
$OUTREACH$	3 dummy variables for the outreach of the MFI	Small, Medium, Large
$Kauffman\ indicator\ 1$	Voice and Accountability	Captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.[7]
$Kauffman\ indicator\ 2$	Political Stability and Absence of Violence	Measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism
$Kauffman\ indicator\ 3$	Government Effectiveness	Captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
$Kauffman\ indicator\ 4$	Regulatory Quality	Captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
$Kauffman\ indicator\ 5$	Rule of Law	Captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence
$Kauffman\ indicator\ 6$	Control of Corruption	Captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption.

[7] All definitions are identical to those provided by the Worldbank.

When both the cost frontier and the inefficiency equation are estimated simultaneously using maximum likelihood, it is important to know how well the model fits the data. This is done by looking at the part of the total variation that is attributed to cost-inefficiency. It is known that $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \frac{\sigma_u^2}{\sigma^2}$, where σ^2 stands for the total variation, σ_u^2 for the variation due to inefficiency and σ_v^2 for the variation due to noise. A high value of γ corresponds to a high explanatory power of inefficiency in the total variation, and thus indicates that the model fits the data well. In the results it can be seen, that γ can have a value between zero and one, and that adding a control variable in the inefficiency equation, can results in a large difference of γ.

4. Empirical Analysis

4.1 Data

In order to investigate the effect of Microfinance Institutions' subsidy dependence on their efficiency, data from the Microfinance Information Exchange (MIX) database has been used. Unbalanced panel data from 203 MFIs of 49 different countries within a period of eight years (2006-2013) has been included in the sample.[8] Next to MFI specific data also country specific data such as the Gross Domestic Product (GDP), and the six Kauffman governance indicators are included. These country specific data are collected from the World Bank.

The Microfinance Information Exchange uses a "diamonds" system to indicate the level of transparency of the MFI and the level of supporting documentation. There is a range of diamonds from 1 to 5 and the higher the number of diamonds the more transparent the MFI and the more reliable the data from the MIX database. For this research only data with 5 diamonds are used to address the effect of subsidies on MFIs' efficiency. It should be noted that for some MFIs data quality has been rated with five diamonds one year, but with four diamonds the following year. Therefore, and due to lack of availability of data of Microfinance Institutions, the data is unbalanced. Table 6 in the Appendix shows the descriptive statistics of all the variables included in the research. Table 3 shows the amount of MFIs for which data is available per year.

[8] Not all MFIs have data available of the donated equity on their income statement. Because this is the main focus of this research these MFIs are excluded from the sample.

Table 3: Observations per Year

Year	Number of observations
2006	82
2007	68
2008	49
2009	50
2010	54
2011	61
2012	40
2013	32
Total	**436**

It can be seen that in total there are 436 observations in the sample, spread over eight different years. It should be noted that there is no Microfinance Institution for which data is included for the entire period (2006-2013). Table 4 shows the number of different types of MFIs included in the sample and the average loan size per type of MFI. Table 4 suggests that there is a large difference in the average loan size from banks, cooperatives and non-bank financials, as compared to NGOs, rural banks and other type of MFIs.

Table 4: Observations per type of MFI and their Average Loan Size

Type of MFI	# in the sample	Average Loan Size (USD)
Banks	120	2380.41
Cooperatives	95	3091.05
Non-bank financial institutions	149	1651.49
Non-governmental organisations	58	384.65
Rural banks	1	244.18
Other	13	556.14
Total	436	1384.65

This suggests that NGOs, rural banks and other MFIs are more focused on lending to the poorest of the poor than banks, cooperatives and non-bank financial institutions. Furthermore there is only one rural bank included in the sample. In order to avoid collinearity, rural banks are excluded from the cost equation.[9]

In the Appendix, table 7 shows that there are 49 countries included in the sample, spread over different continents of the world. Countries from which most observations are obtained are Ecuador, Peru, Bolivia, India and Mexico. Despite the fact that there are numerous MFIs in Africa, there are few observations from African MFIs included. This is due to the fact that

[9] In order to maintain as many observations as possible, rural banks are excluded from the cost equation, instead of MFI type 6: "Other".

data of these MFIs is either unavailable or inconsistent and is therefore unlikely to score five diamonds in the MIXMarket Database. As mentioned above several country-specific control variables are included in the inefficiency equation. This is to avoid a potential estimation bias, when country-specific characteristics have a significant effect on efficiency.

4.2 Results

The cost frontier and the inefficiency equation are estimated simultaneously using maximum likelihood, with STATA. Table 5 shows the results of these estimations. Panel A shows the results of the cost frontier and Panel B the results of the inefficiency equation. The numbers between brackets are the standard deviations from the estimation results.[10] As can be seen, all the variables of the cost function are included in all estimations. For the inefficiency equation however, control variables are added one by one.[11]

Thus, Panel A of Table 5 refers to the estimation results of the cost function. A positive estimation of a coefficient implies an outward shift of the cost function and therefore results in higher total costs. As expected, $LABOUR$ has a positive effect on total costs. The estimations of $LABOUR$ in all specifications are greater than 1 and significant at a 1% significance level. This means that if the total price per unit of labour increases with 1 unit, the total costs of a MFI increase with at least 1 unit. The coefficients for both $CAPITAL$ and $LOANS$ are negative, which is not as expected. However, some of the interaction and quadratic terms are significant and positive, which makes it difficult to directly observe the marginal effect of $CAPITAL$ and $LOANS$ on total costs. Furthermore the dummy-variables for the different types of MFIs are almost never significant. This indicates that the type of MFI has no effect on total costs. In addition, EQ has a negative effect on total costs and estimations are significant in the last two specifications. An increase in the equity ratio of a MFI has a negative effect on that MFIs' total costs. This is in line with expectations, as a high equity ratio is associated with a high-risk strategy, which can result in higher total costs. Table 5, Panel A also shows that in all 6 specifications the variance ratio γ is not zero, which suggests that inefficiency effects are significant in the total cost function of the Microfinance Institution. It should be noted that in the final specification only 10% of the total variation in total costs can be explained by inefficiency. This indicates that 90% of the total variation is

[10] *, ** and *** stand for 1%, 5% and 10% significance respectively.
[11] All Kauffmann indicators are added at once.

Table 5: Results

Panel A	(1)	(2)	(3)	(4)	(5)	(6)
$LABOUR$	1.865***	2.696***	2.443***	2.460***	2.474***	2.455***
	(0.324)	(0.384)	(0.367)	(0.369)	(0.352)	(0.339)
$CAPITAL$	-0.437***	-0.475***	-0.471***	-0.439***	-0.440***	-0.378***
	(0.115)	(0.116)	(0.118)	(0.118)	(0.112)	(0.106)
$LOANS$	-0.704***	-0.729***	-0.693***	-0.693***	-0.864***	-0.543***
	(0.137)	(0.137)	(0.138)	(0.137)	(0.140)	(0.147)
$LABOUR^2$	-0.072***	-0.113***	-0.104***	-0.103***	-0.099***	0.102**
	(0.018)	(0.020)	(0.019)	(0.019)	(0.019)	(0.018)
$CAPITAL^2$	-0.015***	-0.018***	-0.016***	-0.015***	-0.014***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
$LOANS^2$	0.023***	0.022***	0.021***	0.022***	0.027***	0.016***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$LABOUR * CAPITAL$	0.030**	0.036***	0.040***	0.037***	0.034***	0.042***
	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
$LABOUR * LOANS$	-0.014	-0.008	-0.007	-0.010	-0.016	-0.013
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)	(0.010)
$CAPITAL * LOANS$	0.015***	0.013**	0.011*	0.011*	0.012**	0.003
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
$MFITYPE1$ *(Banks)*	0.142	0.217	0.240	0.180	0.208	0.134
	(0.264)	(0.360)	(0.365)	(0.327)	(0.295)	(0.261)
$MFITYPE2$ *(Cooperatives)*	-0.068**	0.059	0.060	0.001	0.007	-0.089
	(0.264)	(0.362)	(0.366)	(0.328)	(0.295)	(0.261)
$MFITYPE3$ *(Non-bank fin ins.)*	0.217	0.277	0.286	0.221	0.239	0.106
	(0.262)	(0.359)	(0.353)	(0.326)	(0.294)	(0.262)
$MFITYPE4$ (NGO)	0.254	0.226	0.233	0.184	0.229	0.108
	(0.264)	(0.361)	(0.365)	(0.327)	(0.296)	(0.263)
$MFITYPE6$ (Rural banks)	0.116	0.124	0.187	0.089	0.105	-0.168
	(0.274)	(0.372)	(0.373)	(0.340)	(0.306)	(0.278)
EQ	-0.165	-0.233*	-0.177	-0.164	-0.244**	-0.295**
	(0.135)	(0.145)	(0.138)	(0.135)	(0.124)	(0.149)
Constant	-5.378***	-10.021***	-8.747***	-8.712***	-6.904***	-9.089***
	(1.855)	(2.248)	(2.192)	(2.187)	(1.968)	(1.864)
Log likelihood	-85.67	-51.79	-47.29	-45.47	-37.17	-21.00
γ	0.934	0.734	0.767	0.766	0.739	0.101
Panel B						
$SUBSIDY$	1.514	-0.308	0.095	0.113	0.504	0.853
	(2.030)	(0.320)	(0.428)	(0.455)	(0.740)	(0.606)
$SUBSIDY^2$	-0.197	0.156	0.019	0.015	-0.034	-0.201
	(0.682)	(0.117)	(0.153)	(0.161)	(0.161)	(0.203)
$LSIZE$		-3.014***	-3.743***	-4.241***	-5.773***	-1.953***
		(0.500)	(0.876)	(1.091)	(1.690)	(0.620)
GDP			3.872**	4.564**	8.540**	4.969***
			(1.728)	(2.145)	(3.664)	(1.481)
$Female$				-0.285*	-0.673**	-0.069
				(0.169)	(0.274)	(0.117)
$OUTREACH$ 1 $(Large)$					0.950*	0.267**
					(0.535)	(0.131)
$OUTREACH$ 2 $(Medium)$					0.599	0.041
					(0.452)	(0.128)
Kauffmann 1						0.222**
						(0.098)
Kauffmann 2						-0.234**
						(0.067)
Kauffmann 3						-0.101
						(0.134)
Kauffmann 4						0.362***
						(0.077)
Kauffmann 5						-0.021
						(0.123)
Kauffmann 6						-0.566***
						(0.143)
Constant	-2.131	2.250***	1.252***	1.444***	0.219	-0.868**
	(1.435)	(0.259)	(0.456)	(0.485)	(0.950)	(0.414)

attributed to random and measurement errors, which means that the data does not fit the model well.[12]

Panel B of Table 5 refers to the estimation results of the inefficiency equation, which is most important in this research. It can be seen that the estimation results of $SUBSIDY$ and $SUBSIDY^2$ are insignificant in all 6 specifications. This indicates that subsidies have no explanatory power in the cost-inefficiency of a MFI. It is an important finding as previous literature has only discussed potential positive or negative effects, however no significant relationship between subsidies and MFI performance is a new finding. In 5 of the 6 specifications the estimated coefficient of $SUBSIDY$ is positive indicating a negative relation between subsidies and donations and cost-efficiency. It should be noted that $SUBSIDY$ is measured as the percentage of donated equity plus donations over total equity of MFI i at time t. To check for robustness also donated equity over total equity and donations over total equity individually have been used as a subsidy measure. However, these different subsidy measures did not change the results of the SFA.

A further essential result is that, $LSIZE$ is significant in all specifications and shows a strong negative relationship with inefficiency. In other words, a higher amount of average loan size decreases inefficiency and thus increases cost efficiency. This follows expectations and could be explained by economies of scale. The fact that the estimations of the variable GDP are significant and positive in specification (3)-(6), suggests that a MFI in a country with a high average GDP per capita is on average less efficient. This is not what one would expect, as a "richer" country is associated with a higher score on efficiency. Furthermore a higher percentage of female borrowers seems to be negatively related to inefficiency and thus positively related to efficiency. This is in line with the findings of previous literature. Also, if the outreach of MFI i at time t is large, this has a significant positive effect on inefficiency. This contradicts the finding that MFIs that lend out larger amounts are more efficient due to economies of scale. It should be noted that the dummy variable $OUTREACH\ 2\ (Small)$ is excluded from the model to avoid collinearity. The estimations of the Kauffman indicators show ambiguous results, displaying a strong negative effect between the control of corruption and inefficiency. Apparently corruption interferes with the efficiency of a MFI. Also the

[12] Although γ is 0.1 in specification (6) this specification has been incorporated in table 7, as it strengthens the finding that subsidies have no significant effect on cost-inefficiency and it shows that 4 out of 6 Kauffman indicators do have a significant effect on MFIs' cost-inefficiency.

political stability and the absence of violence in a country are positively related with the efficiency of a MFI. Kauffman indicator 4, the regulatory quality is significantly negative related to efficiency. This is contrary to expectations, and further research is required to find out why this relationship is negative.

For all observations inefficiency is measured in comparison to an efficiency frontier. Inefficiency measures have a value between zero and one, where one indicates complete inefficiency and zero is located on the efficiency frontier. The following graph shows that average inefficiency increases over time. This is in line with previous literature in which the recent commercialization of microfinance is associated with increasing inefficiency.[13]

Figure 2: The Average Inefficiency per year

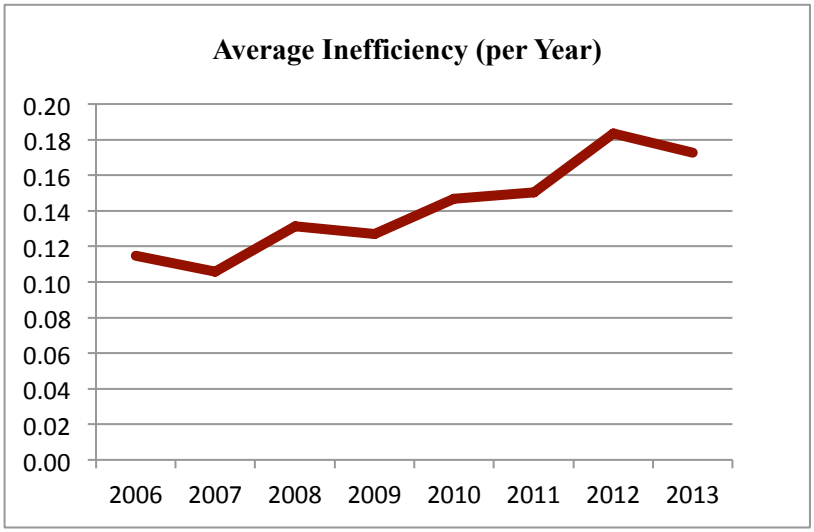


Table 8 in the Appendix shows the average inefficiency per country. It can be seen that Mexico has the highest average inefficiency measure of 0.583. This is the average inefficiency measure of the 23 observations of Mexican MFIs. Mali has the lowest inefficiency measure of 0.017. This is in line with the positive estimation result of GDP and inefficiency, as the average GDP per capita of Mali in 2008 was USD 665 and in Mexico USD 9559.

[13] Hermes et al. (2008) find that there is a trade-off between efficiency and outreach (commercialization)

5. Discussion and Conclusion

In this Thesis a Stochastic Frontier Analysis has been carried out to analyse the effect of subsidies on MFIs' performance, using cost-efficiency as a performance measure. It is found that there is insignificant evidence to identify a relationship between subsidy and donation dependency of a MFI, and its cost-efficiency. Although insignificant, in 5 out of 6 specifications of the analysis subsidies and donations seem to have a positive effect on cost-inefficiency and are therefore negatively related to MFI performance. In addition, the analysis shows that global cost-inefficiency of MFIs is increasing over time. In previous literature, this fact is attributed to the commercialization of the microfinance sector, yet further research needs to be carried out to specify this relationship. Although it is not the main purpose of the research, the SFA does show several important explanatory variables of MFIs' cost-efficiency. Country specific characteristics, such as control of corruption, political stability, absence of violence and GDP, all have a significant effect on the cost-efficiency of a MFI. Also MFI specific characteristics, such as the average loan size and the percentage of female borrowers have a significant positive effect on the cost-efficiency of the MFI. In other words, subsidies and donations coming from governments, NGOs and other donators to MFI's aiming for better performance through an improvement of cost-efficiency, can be better spent. This is an important finding as over the last twenty years, the microfinance sector has attracted over 1 billion USD per year as a subsidy or donation. The findings imply that subsidies and donations with a purpose of gaining MFI efficiency could be better spent on the above mentioned country- and MFI specific variables. This is important information for both public and private policymakers.

Of course subsidies somehow have an impact on the performance of MFIs otherwise what are they for? Yet, the direct effect of subsidies and donations on the cost-efficiency part of MFI performance is found insignificant. Although robustness checks have been performed and several control variables have been added to the model, several drawbacks of the research should be addressed. Firstly the dataset is limited. In total 436 observations have been included in the stochastic frontier analysis. This dataset is relatively small, mainly due to the lack of availability and transparency of data and information on Micro Finance Institutions. Therefore less digitalized and organized MFIs are excluded from the dataset, for whom subsidies and donations might be crucial to gain efficiency. However the data shows that MFIs of different sizes and from 49 different countries are included in the dataset.

Secondly, the measure of the most important variable, $SUBSIDY$ is based on the percentage of donated equity plus donations over total equity of MFI i at time t. However, it is unclear for which purpose these proceeds have been used. This might be important information and requires further research as it could be that certain parts are used as starting capital, that is not included in the cost-efficiency measure but are important for the MFI to be able to exist. Finally, cost-efficiency is a part of a MFIs' overall performance. Further research should be carried out to determine the effect of subsidies and donations on other determinants of overall performance. An example could be the effect of subsidies and donations on the happiness of the borrowers, or on the social performance of a MFI. It would also be interesting if a distinction could be made between the different purposes of subsidies and donations, and which purpose causes the largest increase of efficiency. Because microfinance has been growing rapidly, but only during the past few years, research available is limited. Taken, together with a lack of digital data, implies considerable work still needs to be done to discover the most efficient way to use microfinance to decrease poverty.

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7. Appendix

Yaron's Subsidy Dependence Index (SDI) (1999)

The SDI measures what the interest rates charged to borrowers need to be in order for the bank to operate without subsidies.

$$L(1 + r^*)(1 - d) + I = L + C + S$$

Here L stands for the volume of the loans outstanding before adjustments are made for problem loans. $(1 - d)$ is the fraction of the portfolio that is expected to be repaid, I is total income from other investments, C is the total amount of costs and S is the total value of subsidies. The interest rate (r^*) that causes break-even:

$$r^* = [C + S - I + dL]/[L(1 - d)]$$

Table 6: Descriptive Statistics

Variable name	Obs	Mean	Std. Dev.	Min.	Max.
$Total\ Costs$	436	-1.66	0.43	-3.29	-0.35
$LABOUR$	430	9.82	0.86	7.33	11.24
$CAPITAL$	436	-1.91	1.58	-7.42	8.76
$LOANS$	436	17.49	1.86	12.06	21.58
$MFITYPE1$ *(Banks)*	436	0.27	0.44	0	1
$MFITYPE2$ *(Cooperatives)*	436	0.21	0.41	0	1
$MFITYPE3$ *(Non-bank fin ins.)*	436	0.34	0.47	0	1
$MFITYPE4$ (NGO)	436	0.13	0.33	0	1
$MFITYPE6$ (Rural banks)	436	0.03	0.17	0	1
EQ	436	0.18	0.12	-0.71	0.91
$SUBSIDY$	436	0.03	0.16	-0.003	0.99
$SUBSIDY^2$	436	0.02	0.40	0	0.98
$LSIZE$	436	6.96	1.27	3.61	10.26
GDP	436	3.41	0.41	2.28	4.58
$Female$	436	0.53	0.27	0	1
$OUTREACH\ 1\ (Large)$	434	0.58	0.49	0	1
$OUTREACH\ 2\ (Medium)$	434	0.21	0.41	0	1
Kauffmann 1	436	-0.19	0.43	-2.09	1.06
Kauffmann 2	436	-0.75	0.51	-2.81	0.68
Kauffmann 3	436	-0.46	0.35	-1.67	1.10
Kauffmann 4	436	-0.41	0.57	-1.60	1.45
Kauffmann 5	436	-0.78	0.38	-1.66	1.21
Kauffmann 6	436	-0.61	0.32	-1.42	1.41

Table 7: Observations per Country

Country	Observations	Percentage
Ecuador	91	20,9%
Peru	67	15,4%
Bolivia	41	9,4%
India	25	5,7%
Mexico	23	5,3%
Cambodia	16	3,7%
Paraguay	16	3,7%
Colombia	12	2,8%
Honduras	10	2,3%
Nicaragua	10	2,3%
Philippines	9	2,1%
Bangladesh	8	1,8%
Benin	8	1,8%
Ethiopia	7	1,6%
Pakistan	7	1,6%
Indonesia	6	1,4%
Russia	6	1,4%
Senegal	6	1,4%
Dominican Republic	5	1,1%
Kenya	5	1,1%
Uzbekistan	5	1,1%
Azerbaijan	4	0,9%
Guatemala	4	0,9%
Burkina Faso	3	0,7%
El Salvador	3	0,7%
Mozambique	3	0,7%
Nepal	3	0,7%
Serbia	3	0,7%
Venezuela	3	0,7%
Brazil	2	0,5%
Chile	2	0,5%
Georgia	2	0,5%
Ghana	2	0,5%
Mongolia	2	0,5%
Montenegro	2	0,5%
Vietnam	2	0,5%
Cameroon	1	0,2%
Congo, Democratic Republic of the	1	0,2%
Croatia	1	0,2%
East Timor	1	0,2%
Egypt	1	0,2%
Madagascar	1	0,2%
Malawi	1	0,2%
Mali	1	0,2%
Niger	1	0,2%
Nigeria	1	0,2%
Tanzania	1	0,2%
Uganda	1	0,2%
Yemen	1	0,2%
Total	**436**	**100%**

Table 8: Cost-inefficiency per Country

Country	Inefficiency	Country	Inefficiency
Mexico	0,580	Indonesia	0,063
Philippines	0,462	Nepal	0,059
Tanzania	0,407	Bolivia	0,058
Uganda	0,256	Congo,	0,057
Kenya	0,238	Burkina Faso	0,052
Pakistan	0,221	Mongolia	0,049
Peru	0,191	Cambodia	0,048
Bangladesh	0,177	Nicaragua	0,048
Ghana	0,174	Montenegro	0,047
India	0,169	Chile	0,044
Honduras	0,148	Nigeria	0,035
Paraguay	0,138	Azerbaijan	0,034
Colombia	0,131	Vietnam	0,031
Dominican Republic	0,129	Uzbekistan	0,027
Ecuador	0,108	Egypt	0,027
Venezuela	0,089	Russia	0,027
Georgia	0,086	Croatia	0,022
Brazil	0,082	Niger	0,021
El Salvador	0,079	Guatemala	0,020
Mozambique	0,077	Malawi	0,019
Ethiopia	0,072	East Timor	0,019
Madagascar	0,071	Serbia	0,019
Senegal	0,069	Yemen	0,018
Benin	0,068	Mali	0,017