Economics Bulletin

Volume 39, Issue 3

Total Factor Productivity Change of Senegalese Microfinance Institutions: A Malmquist Productivity Index Approach

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Abstract

The main purpose of this paper was to investigate the change in productivity of Senegalese microfinance institutions (MFIs) during the period from 2009 to 2013. With a balanced panel dataset of 80 observations from the 16 largest MFIs existing in Senegal, we have attempted to highlight the dynamics of microfinance productivity, using the Malmquist productivity index. The results show an average productivity improvement of 1.5% over the period, which is the lowest increase in productivity reported to date. This increase in productivity is mainly due to technological changes, with the change in technical efficiency generally declining in this post-reform period. The decomposition of technical efficiency shows that inefficiency of scale is the main cause of decline in technical efficiency during this period.

The authors would like to thank Sciences Po Toulouse who funded the translation of this article. We also thank the anonymous reviewers for their valuable comments and suggestions to improve this paper. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors.

Citation: François Seck FALL and Harouna WASSONGMA and Waly Clément FAYE, (2019) "Total Factor Productivity Change of Senegalese Microfinance Institutions: A Malmquist Productivity Index Approach", *Economics Bulletin*, Volume 39, Issue 3, pages 1786-1797

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Submitted: July 05, 2018. **Published:** July 23, 2019.

1. Introduction

Microfinance plays a key role in allowing poor and vulnerable people access to financial services (Fall, Akim and Wassongma, 2018; Fall, 2015). In Senegal, as in the rest of West Africa, it plays a crucial role in fighting against exclusion and for the promotion of entrepreneurship. Since its emergence in the 1980s, microfinance has developed considerably and now provides a variety of financial products and services (loans, savings, micro-insurance, money transfers, etc.) to people excluded from the traditional financial system. Today, the usefulness of microfinance is obvious, despite the problems, which are strongly attached to this form of financial intermediation. This sector has experienced unprecedented growth in Senegal, jumping from 18 MFIs in 1993 to nearly 950 in 2009. Since 2008, a new legal framework (Low n0. 2008-47) governing the sector has been set up[1]. Through this reform, the authorities have attempted to promote the diversification of the financial landscape as well as to create a better business environment for the sector, through stronger surveillance and better risk management. One of the challenges of this reform has been the concentration of the sector. In fact, the new law strongly encouraged the grouping of small isolated institutions by creating new networks or joining existing networks. The adoption of the law was also accompanied by the implementation of a consolidation plan initiated by the Department for the Regulation and Supervision of Decentralized Financial Systems (DRS-SFD) of the Ministry of Finance. This has resulted in a considerable drop in the number of isolated MFIs in Senegal, as well as in the entire West African Economic and Monetary Union (UEMOA) region. As of December 31, 2016, the number of MFIs (still called Decentralized Financial Systems or SFDs, within UEMOA) was 383 in Senegal. The logic behind the concentration of the sector was to give priority to a reasonable number of viable MFIs, with a dense network of agencies, rather than having a plethora of fragile, unsustainable institutions, which is risky for savers and for the system as a whole. Another important challenge facing this reform was the professionalization of the sector, particularly SFDs. This reform was not only aimed at updating and strengthening MFI management systems, but also at promoting good governance and financial transparency. It led to the adoption of a new accounting framework for SFDs and a new prudential framework focusing more on the protection of savers and the preservation of their solvency. This modernization also involved efficient management information systems and the promotion of the use of new technologies by MFIs. In addition to increasing the scope of microfinance, this reform was aimed at improving the efficiency and productivity of the microfinance sector. The new accounting framework came into effect on January 1, 2010. At the prudential level, around fifteen instructions were signed between 2000 and 2014 by the BCEAO Governor to supplement the law. These new reforms have introduced several changes in the organization of the microfinance industry. The first change is related to the introduction of a single licensing regime, with the abolition of GECs (savings and credit groups) and structures under contracts. A second change concerns the BCEAO's agreement in issuing the authorization and its intervention in the supervision of SFDs having reached a certain level of activity. A third change concerns the strengthening of the prudential framework and the applicable sanctions. A fourth change concerns mandatory certification of accounts and mandatory membership of the professional association of DFS. Finally, this reform introduced the possibility of creating private limited company

[1] This is a revision of the PARMEC law (project to support the regulation of mutual savings and credit) promulgated since 1993.

The aim of the present paper is to analyzed the productivity of the Senegalese microfinance sector during the period between 2009 and 2013. Our goal is not to assess the impact of the reform, but to analyze the evolution of microfinance productivity and to break it down to see if the explanatory factors are technological or technical. We have used the DEA (data envelopment analysis) method and more specifically the Malmquist Productivity Index to examine the total factor productivity of the 16 largest networks of MFIs in Senegal in this post-reform period[2]. Productivity analysis is necessary in the West African context. It shows whether the new reform has been accompanied or not by an improvement of productivity in the sector. The peculiarities of the Malmquist method make it possible to identify the sources of productivity of the microfinance business, which can be a determining factor in promoting the sector. The analysis of efficiency and performance has witnessed rapid growth in recent years (See Fall, Akim and Wassongma, 2018). Unfortunately, the surveys are more focused on Latin America and Asia, and very few studies have been conducted on West Africa. Research analyzing of productivity is totally absent in this region. We propose to fill this gap, by providing insight on the productivity of microfinance in Senegal. However, this lack of research is not limited to West Africa; research on productivity has so far been scarce, particularly due to the difficulty of finding data over a significant period of time. To the best of our knowledge, no productivity studies have been carried out for UEMOA countries. This contribution is meant as a pioneering work on this issue in the region. The choice of Senegal is justified by the importance of Senegalese microfinance in the UEMOA region. Senegal remains one of the leaders of the zone for most indicators of scope and financial performance. Our choice is also based on the availability of better quality data in Senegal, compared to other countries in the region. Our results show a 1.5% increase in microfinance productivity, due mainly to the technological improvements in the sector. The rest of the article is as follows: Section 2: A brief review of the literature on microfinance efficiency and productivity analysis; Section 3: A presentation of the methodology for estimating productivity and the data used; Section 4: Analysis of the results obtained; and Section 5: Conclusion.

2. Literature Review on Microfinance Efficiency and Productivity Analysis

Productivity and efficiency analysis is a topic of major interest to the microfinance sector. It is particularly useful in identifying best practices within this sector; it is also useful in defining factors that explain efficiency and productivity. A considerable amount of research has been conducted in recent years on this subject (for recent works, see Fall et al., 2018; Bibi et al., 2018; Yimga, 2018). However, the authors of these studies have emphasized the analysis of technical efficiency because of the difficulty to obtain panel data over a significant period of time. Estimating productivity is more constraining in terms of data than technical efficiency. This is why, unlike the analysis of efficiency, productivity has been the subject of few studies. In relation to this lack, the study we propose constitutes a clear contribution to the existing literature. To our knowledge, it is the first contribution to the effort to suggest an analysis of productivity in the UEMOA region in general and in Senegal in particular. Our article also reinforces the limited research studies done on the analysis of the productivity of the microfinance sector.

In existing literature, the analysis of efficiency and productivity is essentially based on two main approaches (Fall, 2018): parametric and nonparametric approaches. Parametric approaches make estimates by econometric techniques, while nonparametric approaches rely

[2] It is important to emphasize that these 16 networks of MFIs are formal structures to which a large number of MFIs are affiliated. The decrease from 950 in 2009 to 303 SFD in 2016 can be explained by the integration of more than 550 MFIs in these 16 networks.

on mathematical estimates of production functions, cost, or profit. The stochastic boundary method (SFA), introduced initially by Aigner et al. (1977), is the most popular among nonparametric approaches. Its peculiarity is to decompose its error term into two components: a part that represents the random error and another part that represents technical inefficiency. However, its implementation requires knowledge of the functional form of the production or cost function. On the other hand, the DEA method, which is the most used among the nonparametric approaches does not require knowledge of the functional form of the estimated function. It is simply based on a linear combination of inputs and outputs. Its defining characteristics are its flexibility and technical simplicity of implementation.

These two methods have been extensively used to estimate microfinance efficiency and productivity. For example, the SFA method was used by Singh et al. (2016), Quayes and Khalyli (2014); Riaz and Gopal (2015), Bos and Millone (2015), Servin et al. (2012), Hermes et al. (2011), Oteng-Abayie et al. (2011), Masood and Ahmad (2010), Hermes et al. (2009), and Paxton (2007). These studies are essentially differentiated by the type of estimated function. There is also a multitude of research based on the DEA approach to estimate the efficiency of microfinance. These include Nghiem et al. (2006), Qayyum and Ahmad (2006), Gutiérrez-Nieto et al. (2007), Bassem (2008), Hassan and Sanchez (2009), Ben Abdelkader et al. (2013), Haq et al. (2010), Kipesha (2012), Piot-Lepetit and Nzongang (2014), Segun and Anjugan (2013), Tahir and Tahrim (2015), Cornée and Tenet (2016), Van Damme et al. (2016), Basharat et al. (2015), Lebovics et al., (2015), Widiarto and Emounznejad (2015), and Wijesiri et al. (2015). This extensive literature on efficiency mainly concerns Asia, Latin America, the Middle East, and North Africa, and has very little impact on Africa, in particular sub-Saharan Africa.

In addition, very little research has been done on productivity analysis for the reasons mentioned above (Fall et al., 2018). Bassem (2014) analyzed the total factor productivity of 33 MFIs in the Middle East and North Africa (MENA) region between 2006 and 2011. The latter found an increase in total productivity of production factors of 4.9%, mainly due to changes related to technical efficiency. On the other hand, the author observes a deteriorating performance in the best MFI practices, with a 2.5 percent drop in technological change. Wijisiri and Moeli (2015) analyzed the productivity of 20 Kenyan MFIs between 2009 and 2012. They find an annual increase in productivity of 7%, mainly due to technological change. Through a post-Malmquist analysis, the latter sought to highlight the impact of some environmental factors on productivity. They learned that mature MFIs tend to have lower productivity, compared to young MFIs. They also found that high economic returns are associated with increased productivity and improved technology. Mia and Chandran (2015) studied the total factor productivity of 162 MFIs in Bangladesh between 2007 and 2012, using the Malmquist approach. They found an overall increase in productivity of 4.3 percent, which is explained by better technical management of resources. By separately estimating financial output and social output, they found an overall increase in productivity of 3.9 percent and 5 percent, respectively, for the financial and social dimensions. Their analysis also identified five MFIs as the best in these two dimensions taken together. Mia and Bassem (2016) reported an overall factor productivity increase of 2.1 percent for the South Asian microfinance sector during the period from 2007 to 2012. They used a panel of 50 Southern Asia MFIs and noticed that the main source of this increase in productivity was the improvement in technical efficiency, which in turn is explained by an improvement in the efficiency of scale in the sector. Gebremichael and Rani (2012) analyzed the productivity of 19 Ethiopian MFIs between 2004 and 2009 using the Malmquist productivity indicator. They discovered an average annual increase in total factor productivity of 3.8 percent. They observed that this increase is largely attributable to the improvement in technical efficiency, which increased by an average of 10 percent over the period under review.

3. Data, Variables and Methodology

3.1. Data and Selection of Variables

The present study used a database of the Senegalese microfinance branch, which is responsible for promoting the sector. The database contains activity data for a sample of 16 largest networks of MFIs from 2008 to 2013. This sample represents approximately 90 percent of the sector in terms of scope (points of service, customer base, and loan portfolio) and assets. The table 1 gives the weight of the 5 largest networks among the networks in our sample. Due to missing data, which negatively impacted 2008, we decided to disregard it and conduct the study during the period from 2009 to 2013. The database provides information on the activities of 23 MFIs, but due to the lack of data, we eventually completed the study on 16 MFIs with data available over the entire period. The DEA method requires data on inputs and outputs of positive values, which forced us to eliminate MFIs for which data were not complete over the entire period. The 16 networks of MFIs represent almost the entire Senegalese microfinance sector, which is an asset for the generalization of results to the whole sector. With this sample, we have nearly 80% of the number of MFIs at the level. The networks with the most affiliated MFIs are CMS (91 affiliated MFIs), ACEP (53), PAMECAS (43) and URMECS (12).

The use of the DEA method to estimate productivity requires specifying a program that binds inputs and outputs. The choice of inputs and outputs depends on the specification chosen for the production function. In the intermediation literature, two main approaches are generally used: the production approach and the intermediation approach (Berger and Humphrey, 1997, Sealey and Lindley, 1977). In the intermediation approach, it is assumed that the bank or the MFI provides credits from the deposits collected. On the other hand, in the production approach, the institution is schematically seen as a firm that produces financial services using capital and labor. The execution of the DEA method requires the orientation of the program. In this study, we have chosen an output orientation. The resulting Malmquist productivity index reflects the equiproportional increase in outputs for a given level of inputs. The choice of the output orientation is consistent with the reality of microfinance in the Senegalese and West African contexts. In this area, microfinance operates more within the logic of broadening scope and financial sustainability than within a view of minimizing inputs on which they have no absolute control. Here, MFIs have no control whatsoever over their resources. They are highly dependent on external resources and do not have the monetary creation power of banks. While minimizing inputs remains a key goal for microfinance, due to the scarcity of resources, achieving sustainability and scaling up their range are at the forefront of MFI strategies. The choice of an output orientation makes sense in this context, although the impact on the results of the estimate can be negligible. In this case, we make estimates of a model with three inputs and four outputs. Table 2 provides a summary of the variables of the model, with the descriptive statistics (average, maximum, minimum standard deviation) of each variable per year. There is an increase in the main inputs and outputs. Expenditures are relatively large compared to the revenues generated. Over the 2009 to 2013 period, expenditures and revenues increased by 91.32% and 92%, respectively. The number of active borrowers increased by 41%. The number of points of service increased by 27.6% and the active total by 27.6%. For the inputs, we have chosen the total expenses, the total assets, and the number of points of service. For the outputs, we have chosen the total products

and the number of active borrowers[3]. The choice of outputs takes into account both the social and financial objective of microfinance. These variables are commonly used in the literature on the analysis of efficiency and productivity (See Fall, 2018). For example, Total Assets and revenues are used by Gutiérrez-Nieto et al. (2009), Piot-LePetit and Nzongang (2014), Wijesiri et al. (2015), Widiarto and Emrouzneja (2015), Fall (2018), etc. The variable "total expenses" is often used in the literature (see Gutiérrez-Nieto et al., 2009 ; Ben Soltane et al., 2008 ; Wijesiri et al., 2015 ; Widiarto et Emrouzneja, 2015 ; Fall, 2018 etc.)

Table 1: Weight of the 5 largest institutions in the sector in June 2014

SFD	Total assets	*Members/Clients*	Active borrowers	Outstanding deposits	Outstanding *crédits*
CMS	*47,9%*	*38,7%*	27,6%	60%	42,70%
PAMECAS	*15,5%*	*29,3%*	*21,7%*	*17,2%*	*14,1%*
ACEP	*12,9%*	*8,9%*	*12%*	*4,6%*	*16,4%*
MicroCred Sénégal	*9,9%*	5,5%	7,2%	7,4%	12,6%
U-IMCEC	*4,1%*	*5,5%*	*6,3%*	*3,3%*	*4,5%*

Source: CNC (2014)/Direction de la microfinance

Table 2: Descriptive statistics of variables (inputs and outputs)

			2009	**2010**	**2011**	**2012**	**2013**
Input	Total expenses (in millions of CFA)	Average	2 327	2 381	2 796	3 965	4 452
		Std dev	4 808	4 994	6 202	8 844	9 868
		Min	109	23	56	97	21
		Max	18 644	19 400	24 720	35 301	39 000
	Number of Pts services (agencies and counters)	Average	32	34	36	37	40
		Std dev	41	46	50	51	52
		Min	5	7	7	6	6

[3] We did not include other variables such as "number of active clients" because of the dimensionality problem. For the model to be valid, the sample size must be at least three times greater than the sum of inputs and outputs (Cooper et al., 2001, Stern et al., 1994).

		Max	171	193	207	209	210
	Total assets (in millions of CFA)	Average	16 100	15 953	18 171	19 843	20 546
		Std dev	37 822	32 756	36 355	38 148	40 314
		Min	405	614	743	634	575
Output	Total amount of revenue (in millions of CFA)	Average	2 534	2 642	3 143	4 328	4 888
		Std dev	5 366	5 296	6 723	9 440	11 495
		Min	41	21	40	66	50
		Max	20 809	20 185	26 530	37 611	46 000
	Number of active borrowers	Average	20 211	24 024	23 476	26 412	28 501
		Std dev	25 118	36 139	32 177	34 534	35 994
		Min	407	240	216	224	190
		Max	84 256	138 086	108 002	113 458	118 032

Source: The authors

3.2. Methodology

Here, we have used the Malmquist productivity index, which is an extension of the DEA model. This approach is particularly suitable for estimating productivity when panel data are available (Worthington, 1999, Grifell-Tatjé and Lovell, 1996). In the literature, three main approaches have been used to estimate the productivity of organizations: the Fisher index, the Tornqvist index, and the Malmquist index. We have chosen the Malmquist index because of its advantages over other methods. First, it does not impose any hypothesis on the minimization or maximization behavior of production units. Second, it does not require information on the prices of inputs and outputs, since the productivity estimate is made on the basis of the quantities of inputs and outputs. Thus, when panel data are available, Malmquist can be used to break down the change in total productivity, which makes it possible to see the share related to the evolution of technical efficiency and the share linked to the evolution of technology. Finally, this technique makes it possible to break down the technical efficiency into a pure component and a component related to the optimal size (efficiency of scale).

The Malmquist index is thus the product of two components: change due to technical efficiency (TEC) and change due to production technology (TC). The first is the evolution of productivity, which is based on better use of inputs and outputs. It highlights the capacity of an MFI to produce the maximum amount of financial services with a given quantity of inputs, or its ability to produce a given quantity of outputs with the minimum possible inputs. The latter, on the other hand, refers to the fact that an MFI achieves a better technical combination of its inputs and outputs through better production technologies (Chandran and Pandiyan, 2008). Such an improvement in the production process is the result of the use of better production technology, for example, through technological innovations. In microfinance, such an improvement can be induced by the improvement of management information systems, as well as the introduction of digital finance to improve distribution channels. At the UEMOA level, particularly in Senegal, this change may also be due to the new regulatory provisions introduced since 2008. By breaking down the total factor productivity, Malmquist allows a clearer identification of the sources of productivity.

For the calculation of the Malmquist productivity index, we used the output orientation, which highlights the equiproportional increase in outputs for a given level of inputs. The Malmquist index is based on the notion of a distance function which, in the case of this research, is a measure of the ability of MFIs to transform inputs into outputs (Shephard, 1970). For a production unit that uses an Xt input set to produce an output set Yt, the production index of Malmquist is then defined by:

$$M_0^t = \frac{D_0^t(Y^t, X^t)}{D_0^t(Y^{t+1}, X^{t+1})} \qquad (1)$$

with D_0^t being the distance function and t the period used as reference. This means that the production technology of the period t is used as a reference for the calculation of the Malmquist index. When the period t + 1 is chosen as a reference, the Malmquist index can be written as follows:

$$M_0^{t+1} = \frac{D_0^{t+1}(Y^t, X^t)}{D_0^{t+1}(Y^{t+1}, X^{t+1})} \qquad (2)$$

The Malmquist index, as Färe et al. (1994) put it, is the geometric mean of the two above indices, giving the following formula:

$$M_0 = (M_0^t * M_0^{t+1})^{1/2} = \left(\frac{D_0^t(Y^t, X^t)}{D_0^t(Y^{t+1}, X^t)} * \frac{D_0^{t+1}(Y^t, X^t)}{D_0^{t+1}(Y^{t+1}, X^{t+1})}\right)^{1/2} \qquad (3)$$

A value above 1 indicates that total factor productivity increased from period t to period t + 1. On the other hand, a value below 1 represents a decrease in total factor productivity between the two periods.

By reformulating equation (3), Fare et al. (1994) have shown that the Malmquist index breaks down into technical change and technological change. Thus, equation 3 is equivalent to equation (4) below:

$$M_0 = \frac{D_0^{t+1}(Y^{t+1}, X^{t+1})}{D_0^t(Y^t, X^t)} * \left[\frac{D_0^t(Y^{t+1}, X^{t+1})}{D_0^{t+1}(Y^{t+1}, X^t)} * \frac{D_0^t(Y^t, X^t)}{D_0^{t+1}(Y^t, X^t)}\right]^{1/2} \qquad (4)$$

The expression outside square brackets in equation (4) measures the change in efficiency between period t and t + 1, while the geometric mean measures technological changes (change of production boundary) between these two periods. In turn, the change in efficiency breaks down into pure technical change and change of scale according to the following relation:

$$\Delta_{Eff\,tech} = \frac{D_{VRS}^{t+1}(Y^{t+1}, X^{t+1})}{D_{VRS}^t(Y^t, X^t)} * \frac{D_{CRS}^{t+1}(Y^{t+1}, X^{t+1}) / D_{VRS}^{t+1}(Y^{t+1}, X^{t+1})}{D_{CRS}^t(Y^t, X^t) / D_{VRS}^t(Y^t, X^t)} \qquad (5)$$

*Changement de l'efficience = Changement technique pure * changement d'échelle*

Change in efficiency = Pure technical change * Change of scale

D_{VRS} and D_{CRS} represent the distance functions in variable scale yields and in constant scale returns, respectively. For each MFI, four distances were calculated: $D_0^t(Y^t, X^t)$, $D_0^{t+1}(Y^t, X^t)$, $D_0^t(Y^{t+1}, X^{t+1})$ *and* $D_0^{t+1}(Y^{t+1}, X^{t+1})$. Each of these distances has been calculated on the CRS option and then on the RSV option, to allow the breakdown of technical efficiency into pure technical efficiency and efficiency of scale.

For the estimation of Malmquist productivity, we used the software DEAP 2.1 of Professor Coelli (T. Coelli, 1996).

4. Empirical Results

Table 3 shows the results of productivity indices. On the whole, there is a 1.5-percent annual increase in total productivity between 2009 and 2013. This is the smallest increase in productivity reported to date in the literature. Over the same period, precisely between 2009 and 2012, Wijesiri and Moeli (2015) estimated an average annual growth rate of 7 percent in Kenya. In the MENA[4] region, Ben Soltane (2014) found an average annual increase of 4.9 percent between 2006 and 2011. Mia and Ben Soltane (2016) found a relatively higher productivity growth in South Asia, with an average increase of 2.1 percent between 2007 and

4 The Middle East and North Africa

2012. For Ethiopia, Gebremichael and Rani (2012) estimated an overall increase of 3.8 percent on average during the period between 2004 and 2009. The detailed analysis of Table 3 shows that this increase in productivity is mainly due to technological change (TC). The evolution of technical efficiency (TEC), however, has slightly decreased over the period, underscoring a worsening of the quality of MFI management. These results are in line with those of Wijisiri and Meoli (2015), who realized that the increase in productivity was due to technological change (TC). They differ from the results of Mia and Ben Soltane (2016) and Gebremichael and Rani (2012), who found that the increase in overall productivity rather resulted from the change in technical efficiency (TEC). This breakdown of global productivity shows that Senegalese MFIs have taken advantage of recent technological innovations to improve their production technology. In fact, the different projects and programs that have been executed under the National Microfinance Development Strategy (SIG) have improved MFIs' performance. The SIG component was a matter of great concern for government authorities, in particular, the Central Bank, due to their desire to improve the reliability of financial information. A computerized treatment center has even been set up with Canada's support, to ensure the delegated management of the SIGs of certain MFIs.

On the other hand, they have not greatly improved the quality of the management of their resources over the period. It is true that MFIs, in particular the large networks, have made an effort to further integrate information and communication technology (ICT) in their management (Fall and Birba, 2015) by testing new digital financing solutions (electronic wallets, prepaid cards, tablets to offer certain services directly on the field), which may explain this increase in productivity. For example MicroCred is ahead in terms of technological innovations. Its information system (T21) is the world reference in the field of banking and finance. This system ensures the availability of reliable and complete information in real time, regardless of the location of the Agency. MicroCred has also introduced major innovations in distribution channels to lower installation and operating costs. It has developed a network of classic correspondents called "Baobab Points" and dedicated agents[5]. However, the management of resources remains unsatisfactory, as shown by its negative effect on the overall evolution of productivity in the sector. Many governance problems have been noted both in medium-sized MFIs and in large networks. As a result, several MFIs have been placed under temporary administration and are being rehabilitated.

Breaking down technical efficiency makes it possible to identify the sources of its degradation over the period under review. The negative contribution of technical efficiency to the overall productivity is mainly due to the inefficient scale of MFIs. Pure technical efficiency has evolved almost constantly over the period (0.1 percent), while the efficiency of scale has decreased relatively (-1.7 percent), justifying its negative contribution to the overall trend in technical efficiency over the period reviewed.

Table 3: Malmquist index summary of annual means

Year	Technical efficiency change (TEC)	Technological change (TC)	Pure technical efficiency change (TE)	Scale efficiency change (SE)	Total factor productivity change (TFP) (Malmquist)
2010	1,022	0,946	1,026	0,997	0,967
2011	0,96	1,004	0,984	0,975	0,963
2012	1,023	1,117	0,988	1,036	1,143
2013	0,932	1,067	1,006	0,926	0,994
mean	**0,984**	**1,031**	**1,001**	**0,983**	**1,015**

[5] On the other hand, MFIs like PAMECAS are struggling to succeed in this "digital transformation".

Source: The authors

There was a decrease in overall productivity for 50 percent of the reviewed institutions. On average, only 3 out of 16 networks of MFIs experienced an increase in their technical efficiency between 2009 and 2013. However, more than 62 percent of MFIs experienced a positive evolution in technological change. Many microfinance institutions have witnessed a fall in the efficiency of scale (9 out of 16), while pure technical efficiency has remained unchanged for nearly 70 percent of MFIs. Table 4 shows that the result on the overall evolution of productivity hides disparities between MFIs. Some institutions, such as UFM and CMS, contributed positively to the increase in overall industrial productivity during the period, with productivity up by 15.2 percent and 7.8 percent, respectively. On the other hand, others, such as UMECAS, MECAP, and DJOMEC, contributed negatively to the overall productivity of the sector, respectively with productivity down by -9 percent, -6 percent and -6.8 percent. UMECAS and DJOMEC, following serious problems of governance and outstanding payments, were placed under temporary administration and under close supervision. These overdue obligations, marked by the deterioration in the quality of the rural portfolio and micro and small businesses, were also favored by the culture of over-indebtedness of certain customers and accentuated by the delays in the operationalization of the credit information office. Institutions like ACEP, PAMECAS, and UMECAS experienced a joint fall in their technical efficiency and technological change during the period. The last two MFIs suffered greatly from the quality of their SIGs, which makes the risk management system more vulnerable.

In addition, bodies, such as CMS and UFM, have witnessed a positive increase in their technical efficiency and technological change. The greatest productivity was obtained by UFM, the last network created and operating in rural areas. Set up as a result of a joint project of the nongovernmental organizations (NGOs) AQUADEV and CISV, this network has a reputation for being well managed due to the quality of its technicians and the support of producer organizations.

Table 4: Malmquist index summary of MFI network means

Network	Technical efficiency change (TEC)	Technological change (TC)	Pure technical efficiency change (TE)	Scale efficiency change (SE)	Total factor productivity change (TFP) (Malmquist)
ACEP	0,998	0,961	1	0,998	0,959
CAURIE-MF	1	1,01	1	1	1,01
CMS	1,026	1,051	1	1,026	1,078
COOPEC-RESOPP	0,96	1,051	0,957	1,003	1,008
DJOMEC	0,895	1,042	1	0,895	0,932
FDEA	1	1,261	1	1	1,261
FEPRODES	1	0,988	1	1	0,988
INTERCREC	0,991	1,057	1	0,991	1,048
MECAP	0,956	0,977	1	0,956	0,934
MICROCRED	1	1,033	1	1	1,033
PAMECAS	0,993	0,999	1	0,993	0,992
REMEC	0,974	1,056	1,034	0,942	1,028
UFM	1,058	1,089	1,057	1,001	1,152
U-IMCEC	1,011	0,968	1,014	0,996	0,978
UMECAS	0,922	0,987	0,957	0,963	0,91
URMECS	0,967	1,006	1	0,967	0,973

Mean	0,984	1,031	1,001	0,983	1,015

Source: The authors

5. Conclusion

This article attempted to analyze the total factor productivity in the Senegalese microfinance sector in the period following the implementation of the latest legal reform of the sector in the UEMOA region. We used the nonparametric approach to data envelopment and the Malmquist index to break down the overall productivity of the sector. The study examined a sample of 80 observations from 16 microfinance networks over the period 2009 to 2013. Our estimates show an overall sector productivity increase of 1.5 percent in this post-reform period. This statistic is, to date, the lowest increase underscored in the literature. Nevertheless, it shows the positive dynamics of factor productivity after the introduction of the last reform. The breakdown of the Malmquist index shows that this increase is attributable to technological change, which rose by 3.1 percent over the period. On the other hand, technical efficiency decreased during the period considered, negatively impacting the increase in overall productivity. The sub-breakdown of technical efficiency in turn shows that this decline in technical efficiency is largely attributable to inefficiency of scale. The major lesson to be learned from this study is that technological and regulatory innovations have made it possible to increase the overall productivity of the Senegalese microfinance sector. More specifically, these positive changes are attributable to the integration of new technologies into the intermediation activity of microfinance, but also to the new business environment triggered by the 2008 reform. Senegalese microfinance could also have higher productivity had it not been negatively impacted by the decline in the quality of management within MFIs. These results seem to be in line with those of a recent study on Senegalese microfinance in this post-2008 period. It highlighted the positive impact of information technology and the dynamics of MFIs' networking on the social performance of MFIs (Fall and Birba, 2015). This analysis contributes to microfinance literature. To our knowledge, this study is the first to provide an analysis of the productivity of microfinance in Senegal and West Africa. Its contribution sheds light on the positive impact of technological innovations and the new reform on the performance of microfinance in Senegal.

However, this analysis is limited by the availability of data. A larger sample over a longer period would be able to provide more interesting information on the issue under scrutiny Thus, although the results are generalizable to the other countries of the region, given their close economic proximity, the fact remains that an analysis of the area as a whole would yield more interesting conclusions in this field. Given these limitations, future research work should incorporate data on a larger sample and a longer period, to allow for a more complete analysis of productivity in Senegal and in UEMOA as a whole.

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