STOCHASTIC MODEL OF MICROCREDIT INTEREST RATE IN MOROCCO

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Abstract

Access to microcredit can have a beneficial effect on the well-being of low-income households excluded from the traditional banking system. It allows this population to receive affordable financial services to help them to meet their needs and to improve their living conditions. However to provide access to credit, microfinance institutions should ensure not only their social mission but also commercial and financial mission to enable the institution to perpetuate and become self-sufficient. To this end, MFIs (microfinance institutions) must apply an interest rate that covers their costs and risk, while generating profits, Also microentrepreneurs need, to this end, to ensure the profitability of their activities.

This paper presents the microfinance sector in Morocco. It focuses then on the interest rate applied by the Moroccan microfinance institutions; it provides also a comparative study between Morocco and other comparable countries in terms of interest rates charged to borrowers. Finally, this article presents a stochastic model of the interest rate in microcredit built in random loan repayment periods and on a real example of the program of loans of microfinance institution in Morocco.

Keywords: Microcredit, Micro-Finance Institution, Interest Rate, Morocco, Poor Population

1. INTRODUCTION

Microfinance has emerged to provide a social main mission realized through the eradication of poverty and by insuring a social and economic inclusion of the poor, excluded from the traditional banking system and with a large financing needs to improve their living conditions. This is realized through the offer of financial and non-financial products and services enabling the poor population to increase its assets; improve their level of consumption, manage risk effectively and to improve their health and education.

In Morocco, Microfinance institutions financed the micro-entrepreneur which is considered as an active customer, a plaintiff against repayment of financial services that it needs for developing his activity.

It should be noted that in Morocco, the definition of the poor is not necessarily recognized by the international standards that determine the poverty threshold as a reference. It consists indeed in analyzing the wealth and housing indicators to identify customers. The analysis of wealth involves working with the community to rank the members from the richest to the poorest and housing indicators measure the level of poverty of individuals based on building materials used in the external part of their homes. Moreover, if it remains that the overarching priority of microfinance is the poor customer, the focus is strongly put on the female poor customer, because they represent a large mass marginalized in developing countries and have great difficulties to access to resources *(Zahraoui, 2007).*

Furthermore, the microfinance mission is not only social but also financial, all MFIs must ensure its sustainability and its growth, this by applying interest rates allowing them to offer permanent and large scale financial services *(Churchill & All, 2001).*

The interest rates must both absorb and cover all costs while generating profit what makes them often higher than those charged by conventional banks, because it is obviously more expensive to lend and collect a given amount distributed in several thousands of tiny loans rather than lend and collect that amount divided into some major loans. Higher costs must be covered by higher interest rates. But how could this rate be high? Many people fear that these high interest rates cause an over indebtedness of poor people without other funding resources (Hajdenberg, 2007).

This paper present an overview of the microfinance sector in Morocco and focuses on the interest rates applied by these institutions to ensure their financial sustainability. It is organized as follows:

Section 2 provides an overview of the mission and the achievements of microfinance sector in Morocco and presents costs supported by microfinance institutions. Part 3 presents the interest rate applied by the Moroccan microfinance institutions and provides also a comparison between Morocco and other comparable countries in terms of interest rates charged to the micro-entrepreneurs. Finally, we conclude this summary paper with a stochastic model of the interest rate in microcredit built in random loan repayment periods and on a real example of the program of loans of microfinance institution in Morocco.

2. MICROFINANCE SECTOR IN MOROCCO

2.1. Mission and goals

The microfinance sector in Morocco is one of the player in the fight against poverty through financial inclusion and job creation. The Moroccan outstanding microcredits represent 0.6 % of the gross national product in 2014.

The microfinance activity in Morocco is governed by the Law 18-97 of February 1999) as well as the laws that complete and modify the previous text (Law 58-03 of April 2004, law 04-07 of 30 November 2007 and law 41-12).

This sector is an industry relatively diversified with 13 Associations of Microcredit (AMC) grouped in a representative federation FNAM (National Federation of Microcredit Associations) under the supervision of the Central Bank of Morocco *(Bennouna, 2016)*

2.2. Products and Services

Increasingly the AMCs offer diversified financial products to meet the needs of their customers, but because of their institutional status, they do not have the right to collect savings.
These products include:

2.2.1. Microentrepreneurs loans

Microentrepreneurs loans are granted to individuals or groups of 2 to 5 persons wishing to develop their own income-generating activity.

2.2.2. Housing loans

Housing loans are granted to persons wishing to acquire, build or improve their homes, or to be equipped with electric installations or to provide the drinking water requirements.

2.2.3. Microinsurance

Microinsurance is a mechanism of protection of the micro-entrepreneurs against risks (hospitalization, death, flood, fire ...) in exchange for the payment of premiums adapted to their needs, their income and their level of risk. It allows to all micro-entrepreneurs to benefit from an insurance coverage even those working in the informal sector who are often poorly served by commercial insurers and traditional social insurance systems.

2.2.4. Money Transfer

Given that microfinance institutions (MFIs) usually target low-income customers and customers located in underserved geographical areas, money transfers allow MFIs to reach their social goals by offering an additional service asked by poor customers – at a cost often lower than those proposed by the "traditional" providers (Isern, Deshpande, and Doorn 2005). AMCs offer in this sense to their customer domestic and international money transfer services.

2.3. Achievements of the Sector

According to the Mohammed VI foundation for solidarity, the sector offer 6,400 permanent direct jobs and thousands of indirect jobs to 30/09/2015. There were more than 1 300 points of sale on the whole territory. The coverage rate of the population is estimated at 60% in urban areas and almost 40% in rural areas; more than 52.7% of points of sale are located in urban areas and 47.3% in rural areas. AMCs are located practically in all regions of the country and especially in areas with a high rate of poverty.

The served population represents more than 900.000 customers at 30/09/2015 and an outstanding loan which exceeds 6 billion *(C.M.S-September 2015).*

2.4. Costs

Furthermore, AMCs are required to cover certain fixed and variable costs namely:

2.4.1. The Operating costs

The operating costs include offices and supplies, training and employee compensation, also transport and communications, and depreciation of buildings and equipment. Those operating costs constitute the main component of the rate charged to borrowers by MFIs and are situated most of the time in the range of 10 to 25% of the average outstanding loans.
In Morocco, The operating costs represent 13.5% over the past years. It includes salary expenses which are estimated at 434 Mdhs (9%) and operating expenses estimated at 4.5% (White paper of microcredit in Morocco).

2.4.2. Costs related to credit losses or costs of risk

Costs related to credit losses or costs of risk represent the provisions for bad debts net of recoveries. On average in Morocco, it represents 3.5% of the outstanding loan or the share of non-performing loans.

2.4.3. Financial costs and funding sources

Most associations are private and autonomous, for many years. But, they have to be financed continually to ensure their sustainability; this funding is usually done at an average rate of 5.5%, essentially by medium and long-term loans. However, it should be noted that the sector has benefited from significant support at the start of its activity both in terms of technical assistance and at strengthening of credit funds. Table 1, below, summarizes the importance and the allocation of this assistance provided both from institutional and private sector at the national and international level:

Table 1. Synthesis of grants received by the sector over the past years

Synthesis of grants received by the sector	
Donations for loan fund	188 150 899
Operating grants	206 906 745
All	395 057 644

3. MICROCREDIT INTEREST RATE IN MOROCCO

As explained in the previous section, MFIs must be able to carry out, in order to succeed, a number of fixed or variable costs, while generating profits. The costs include operating costs, the cost of funds and the expected credit losses (CGAP 2007 & 2004).

These MFIs receive reproaches regarding to the applied interest rate considered too high. This is mainly due to the high costs leaned by these institutions: operating costs (which represent more than 10 % of the interest rates charged by the MFIs by using the yield on gross portfolio as an approximation of the interest rates (Rosenberg, 2013)), and also loan loss expense that are important (delays in payment of the terms by borrowers or outright non-payment). It should be noted that microfinance institutions grant a free deadline for delays given that its target consist mainly of poor, which results a smaller interest rate *(Yunus, 1997*). The following part of this paper illustrates the behavior of interest rate in microcredit in Morocco.

In Morocco, the interest rate varies between 18% and 37% depending on the nature of the loan, the type of financed activity and on the size of the microfinance institution. A comparative study of the applied interest rates by region and Country for the Middle East & North Africa region (MENA) (table2) allows to position Morocco compared with other countries on one side and to highlight conclusions based on the financial profitability of MFIs on the other hand (Fernando, 2006).

Table 2. MFI Interest yield distribution, 2014

Region	MFI Count	Yield on gross portfolio (real)	Yield on gross portfolio (nominal)
Africa	145	**24.84 %**	**31.37 %**
East Asia and the Pacific	112	**24.65 %**	**31.10 %**
Eastern Europe and Central Asia	104	**23.79 %**	**30.19 %**
Latin America and the Caribbean	304	**25.34 %**	**30.07 %**
South Asia	146	**14.09 %**	**23.71 %**
Middle East and North Africa	26	**24.36 %**	**32.42 %**
Morocco	6	37.66 %	40.24 %
Egypt	4	27.95 %	36.80 %
Iraq	1	2.17 %	4.09 %
Jordan	4	26.88 %	33.99 %
Lebanon	2	28.74 %	32.85 %
Palestine	4	16.04 %	18.01 %
Sudan	1	3.66 %	41.52 %
Syria	2	-12.69 %	38.91 %
Tunisia	1	19.20 %	26.48 %
Yemen	1	16.72 %	29.52 %

Source: Yield on gross portfolio, 837 MFIs reporting to MIX.

According to this comparative study, it appears that the interest rates charged in Morocco are high. This is mainly due to the actions implemented after the period of the crisis experienced by microfinance sector in Morocco *(Bennouna, 2016),* and which are translated by the exchange of historical data by all MFIs on their customers in an informal way to identify multiple borrowers. In addition, the MFIs have also reviewed and tightened their lending policies to new customers. Inevitably, this led to a reduction in borrower's number and an increase of operating expenses. Indeed, the staff spent more time and efforts to cover bad debts. This had a negative impact on efficiency, as shown by the increase of operating costs.

However, efficiency gains accumulated over several years enabled the Moroccan microfinance sector to be among the most efficient in the region.

Moreover, a broader analysis of the interest rates applied in Morocco will be the subject of the next part; it deals with the realization of a stochastic model of the interest rate based on the behavior of borrowers and the practices of microfinance institution in Morocco.

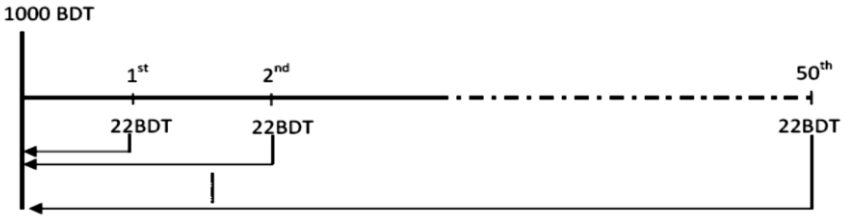
4. STOCHASTIC MODEL OF MICROCREDIT INTEREST RATE

Given that the estimation of the interest rate is linked to the cost of risks, this section allows to measure the impact of delays or default on the increase or the reduction in interest rates based on a model realized by Mohamed Yunus.

We consider the model created by Mohamed Yunus as our base model *(Yunus, 2007).* The effective annual interest rate of the credit is computed from this model represented by an equation. This equation is illustrate through the following example: if a borrower takes an income-generating loan of 1000 BDT (which is equivalent to 123DHs) split in 50 installments of 22 BDT paied in week , he will pay a total amount of 1100 BDT. Within this amount, 1000 BDT is the principal and 100 BDT represents the interest for the year, which corresponding to 10% flat rate according to Yunus Model (Mauk, 2014).

The figure 1 bellow illustrate the repayment scheme of weekly installments.

Figure1. Weekly installments



If we denote by r^y the annual implicit interest rate. The Yunus equation which defined the interest rate is:

$$1000 = \sum_{k=1}^{50} 22\, e^{-t_k \frac{r^y}{52}}$$

Equation 1: the non-stochastic Yunus equation

The solution of this equation leads to an implicit yearly interest rate approching 20% which is given by Yunus.

The problem is that the effective rate calculated according to this equation does not take into account certain random aspect of repayment deadlines. A customer can shift or postpone the payment for one or more weeks which causes a delay in all the subsequent settlements.

To take this into account, we introduce a stochastic process for installments dates T_k which integrates the delays in repayment (Diener, 2015).

In this case the generalized Yunus equation is as follow:

$$N = \left(1 + r_f\right) \sum_{k=1}^{N} Q^{T_k} \qquad with\ Q = e^{-\frac{R_N}{N}}$$

Equation 2 : the generalized Yunus equation

In the first example given by Yunus, N=50; r_f which is the flat rate corresponds to 10% and the implicit interest rate is $r^y = \frac{N+2}{N} R_N$ which becomes random given that T_k are random.

4.1. Stochastic Model for Installments Dates T_k

In this part, The main purpose is to find the law of the implicit interest rate taking into account the case of delays in installments and to identify the distribution of random repayment time and inter-repayment time.

Furthermore, a probability is assigned to the act of repayment p.

Let B=$(B_m)m \geq 1$ be a Bernoulli process , (B_m) ➔ B(1,p).

$$B_m = \begin{cases} 1 & If\ borrower\ succeds\ to\ pay\ the\ installment\ at\ time\ m \\ 0 & Otherwise \end{cases}$$

Given a repayment process, we are interested in a sequence of random variables, $\boldsymbol{T_k}$ corresponding to the time when the k-th repayment occurred possibly after having accidents of no repayment. The k-th installment takes place at (The F^B stopping –time):

$\boldsymbol{T_k} = \boldsymbol{min}\{\boldsymbol{m}\ /\ B_1 + \cdots + B_m = k\}, k = 1 \ldots N.$

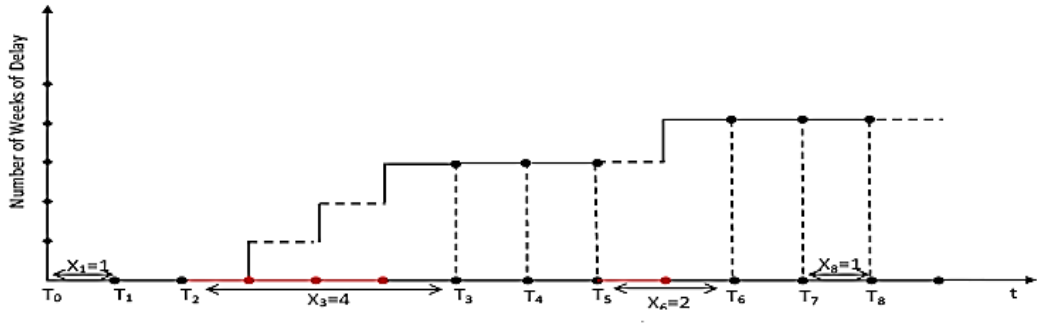
$\boldsymbol{X_k} = \boldsymbol{T_k} - \boldsymbol{T_{k-1}}$ is the time to k-th installment, with $T_0 = 0$.

Then we find that P(X=x) = $p(1-p)^{x-1}$ so $\boldsymbol{X_k}$ ➔ G(p), the geometric distribution.

This allows choosing a reasonably realistic value of p. Indeed, if we take the often-cited 3% of default-rate and if we consider that default means that some $\boldsymbol{X_m} > 4$, we get p = 0,84, value that we will use in our examples.

The figure2 bellow presents an example of weekly repayment process with some accidents of delay.

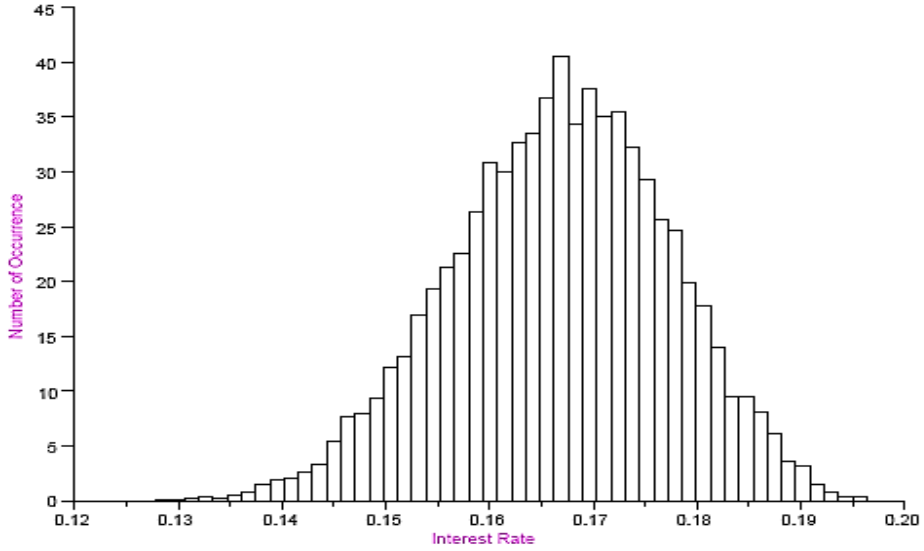
Figure 2. Delay in repayment



Using Scilab we built a sample of size 10 000 of random installments of lending.

The figure3 illustrates the distribution of the actuarial interest rate $\boldsymbol{R_N}$ computed from the generalized Yunus equation for N = 50 and $\boldsymbol{r_f}$ = 10% on a Monte-Carlo sample of 10 000 borrowers.

Figure3. Interest rate distribution, p=0.84, sample size=10 000



So the effective interest rate in this case is not 20% but actually **16.59%.**

The implicit interest rate computed for the case of Morocco according to the generalized Yunus equation is the subject of the next part.

4.2. Implicit Interest Rate in Morocco

As stated previously, the interest rate in Morocco varies from 18% and 37%. In this section, we will consider an interest rate around **36%**, which is applied for microentrepreneur loans who represents over than 95% of the Moroccan microfinance portfolio *(CMS Dec 2015).*

It should be noted that in Morocco, installments are paid monthly and not weekly. So considering a flat interest rate of 18% and a loan amount of 1800Dhs with monthly payments: 18 months; we get the following interest rate:

$1800 = 118 \sum_{k=1}^{18} (e^{\frac{-r}{20}})^k$; r is the annual interest rate

⇨ $118\, q^{19}$-1918 q+1800=0 With $q=e^{\frac{-r}{20}}$

⇨ **r= 0,35749613 ~36%** which corresponds to the applied rate

Let $N = (1 + r_f) \sum_{k=1}^{N} Q^{T_k}$ [3] $with\ Q = e^{-\frac{R_N}{N}}$ the generalized Yunus equation

$r_f = 18\%$; The default-rate is around 3% and if we consider that default means that some $\boldsymbol{X_m}$>4 weeks/ one month, we get p = 0.84 value that we will use in this illustration.

Using Matlab we built a sample of size 10 000 of random installments of lending.

Then from the distribution of actuarial interest rates $R_N$computed from equation [3] for N=18 months, and $r_f = 18\%$, we find an implicit interest rate of around 30%.

For more precision, If we denote by $\bar{r}$ the amount which satisfies the equation:

$$1800 = E\left(\sum_{k=1}^{18} 118\, e^{\frac{-r}{20}(X_1 + X_2 + \cdots\ldots\ldots + X_k)}\right)$$

Then $\bar{r} = \mathbf{20}\, \boldsymbol{ln}\, (\mathbf{1} + \boldsymbol{p}\left(\frac{\mathbf{1}}{\boldsymbol{q}} - \mathbf{1}\right))$ with q: the solution of the non-stochastic Yunus equation

As previously, we have q= 0.982284 & p=0.84 ➔ then $\bar{r} = \mathbf{30}\%$ which is the solution found.

CONCLUSION

Microcredit's main objective is to maximize the benefit of the poor. From this perspective, the level of interest rates charged by microfinance institutions is not interested, as far as this excluded population from the traditional banking systems is served and benefits not only from the basic necessities but also from a planning of their future and from an improvement of their living conditions.

It is worth noting that in most countries including Morocco, funding from donors are of a limited quantity which forced microfinance institutions to apply relatively high interest rates to ensure the financing of a large poor population while preserving their financial stability.

In this article, the comparative study of interest rates by country and the estimation of the implicit interest rate applied in Morocco brings out a broad vision on the practices of microfinance institutions in Morocco in terms of supported costs and in return interest rates charged. This study place Morocco among the countries with high interest rates, but this is mainly explained by the crisis that crossed this sector which was caused by the over-indebtedness of the customers and the increase of the default risk and which required heavy financial interventions by MFIs to ensure their survival and financial viability and then overcome the crisis. On this matter, MFIs in Morocco adopted a preventative approach through the application of a diverse target pricing according to the microentrepeurs risk scoring.

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