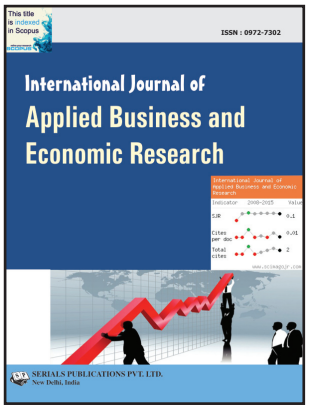

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Agent Based Modeling of Islamic Microfinance with Cooperatives and Takaful System

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ABSTRACT

Since its inception in the early 1980s, microfinance has been widely acclaimed as a paradigm for poverty alleviation in addition to enhancing economic and social development in developing countries. Islamic microfinance (IMF) represents the reunion of microfinance and Islamic finance. IMF intended to facilitate the access of the low-income populations to credit based on Islamic finance products, which prohibits interest rates on loans and cash investments considered a Riba, thus sharing commercial profits or losses. The purpose of this paper is to assess the benefits of encouraging clients of the Islamic microfinance institutions to organize themselves into cooperatives. In Order to present, the benefits of creating cooperatives using a Takaful system, we implemented a model using NetLogo, an agent-based environment, which introduces the use of a Takaful strategy to allow cooperatives to become more efficient. This work considers a new temptation for designing an agent-based model allowing the improvement of the efficiency of the Islamic micro financing with cooperatives and Takaful strategy.

JEL Classification: G11, G12, D58, C00.

Keywords: Microfinance; Islamic microfinance; cooperatives; Takaful; Agent based modeling.

1. INTRODUCTION

In her book "the revolution of Microfinance" [1], Marguerite S. Robinson defines Microfinance as a set of *"small-scale financial services, primarily credits and saving, provided to people who farm or fish or herd; who operate small enterprises or microenterprise where goods are produced, recycled, repaired or sold; who provide services; who work for wages or commissions; who gain income from renting out small amounts of land, vehicles, draft animals, or machinery and tools; and*

to other individuals and groups at the local levels of developing countries, both rural and urban. Many such households have multiple source of income. Saving services allow savers to store excess liquidity for future use and to obtain returns on their investments. Credit services enable to use of anticipated income of current investment or consumption. Overall, microfinance can help low-income people reduce risk, improve management, raise productivity, obtain higher returns on investments, increase their incomes and improve the quality of their lives and those of their dependents."

Such services are rarely accessible through the formal financial sector. Credit is widely available from informal commercial moneylenders but typically at a very high cost to the borrowers, especially low-income borrowers. Banks generally assume that providing small loans and deposit services would be unprofitable.

This pattern is changing though: new institutions, known as Microfinance institutions (MFIs) have emerged in several countries to fill the financing gap between the banks and moneylenders. MFIs access financial resources from banks and other mainstream Financial Institutions and provide financial and support services to poor. MFIs are like small banks with the same challenges and capital needs confronting any expanding small venture but with the added responsibility of serving economically-marginalized populations. The main goals of MFIs should be, to name but a few:

- Improving the quality of life of the poor by providing access to financial and support services,
- Mobilizing resources in order to provide financial and support services to the poor, particularly women, for viable productive income generation enterprises enabling them to reduce their poverty,
- Creating opportunities for self-employment for the underprivileged,
- Training rural poor in simple skills and enabling them to utilize the available resources and contribute to employment and income generation in rural areas.

Microfinance is most closely associated with the Bangladeshi economist Dr. Muhammad Yunus founder of the Grameen Bank in Bangladesh, and Rakyat Banks in Indonesia and Malaysia [26]. These institutions have provided financial products tailored to the categories of populations exluded from conventional financing, applying a collective system for monitoring risks to optimize the reimbursement of the appropriations.

In this work we are interested in modeling and simulation of cooperatives using a Takaful system. We use the agent based modeling [8], [9], [10] and [11], and the simulation is did using NetLogo[28].

This paper is organized as follows : The next section (§ 3) defines the principle of cooperatives and their contribution in the economic welfare, then in the following section (§ 4), we present the main issue of this study, followed by market data of the Moroccan market (§ 5). Further, in sections (§ 6 and § 7) we introduce the multi-agent based model and describe the simulations done alongside with the outputs. Finally the last section is dedicated to the conclusion and to some possible extensions that will be performed subsequently.

2. COOPERATIVE PRINCIPLES AND BENEFITS

A cooperative is a business voluntarily owned and controlled by the people using its services. Cooperatives around the world generally operate according to the same core principles and values, adopted by the International Co-operative Alliance in 1995. Cooperatives trace the roots of these principles to the first modern cooperative founded in Rochdale, England in 1844.

1. **Voluntary and open membership:** Cooperatives are voluntary organizations, open to all people able to use its services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.
2. **Democratic member control:** Cooperatives are democratic organizations controlled by their members—those who buy the goods or use the services of the cooperative—who actively participate in setting policies and making decisions.
3. **Members' economic participation:** Members contribute equally to, and democratically control, the capital of the cooperative. This benefits members in proportion to the business they conduct with the cooperative rather than on the capital invested.
4. **Autonomy and independence:** Cooperatives are autonomous, self-help organizations controlled by their members. If the cooperative enters into agreements with other organizations or raises capital from external sources, it is done so based on terms that ensure democratic control by the members and maintains the cooperative's autonomy.
5. **Education, training and information:** Cooperatives provide education and training for members, elected representatives, managers and employees so they can contribute effectively to the development of their cooperative. Members also inform the general public about the nature and benefits of cooperatives.
6. **Cooperation:** Cooperatives serve their members most effectively and strengthen the cooperative movement by working together through local, national, regional and international structures.
7. **Concern for community:** While focusing on member needs, cooperatives work for the sustainable development of communities through policies and programs accepted by the members.

Cooperative allows members to pool their financial resources and conduct business activities they could not independently perform as efficiently, here after some reasons for joining a cooperative: obtain a fair or efficient price, reduce costs through economies of size, pool risks, provide markets, supplies, and services that are missing or in danger of being lost, capture profits from another level and benefit from increased market power. For more details about microfinance and cooperatives study, we can see [1], [2], [3], [4], [5], [6], [7], [8], [18], [19], [20], [22] and [27].

3. ISSUE

However, despite the many efforts of the classic microfinance to achieve the goals above-mentioned, a large proportion of poor people remains out of this system. This is mainly due to the high interest rates and the lack of guarantees. This has led many small low-revenue people to create work groups, operating in the same industry, or having significant synergies called cooperatives, in order to strengthen their creditworthiness and realize large economies of scale enabling them to reach high performances.

It is in this regard that we are interested in the modeling and the simulation of cooperatives based on the principles of Takaful and mutual help. In fact, cooperatives participate in no small way in the promotion of many industries and are therefore a promising opportunity for development in the world, in particular in Morocco.

Before going through modeling, we will briefly present some sector data in Morocco [24]. Simulations performed in this paper are intended to cover the general principle of cooperatives and the Takaful system, however, some numerical resultats are displayed to illustrate the concept. The Moroccan case will be processed in a further extension of this paper.

4. MOROCCAN CASE

The Moroccan cooperative sector plays a leading role in sustainable development. It occupies an important place in the economic and social development programs. A place that is reinforced by the National Initiative for Human Development (INDH), launched by His Majesty King Mohammed VI on May 18 2005. This has resulted in the evolution of the number of cooperatives a rate of over 178% between 2005 and 2014 [22].

Moroccan cooperative tissue account 13,822 cooperatives and cooperative unions with 461,878 members (at 31 December 2014), divided into twenty sectors and in hundreds of activities. It is characterized by the structural dominance of three sectors: agriculture, crafts and habitat with 66.7%, 15.2% and 8.1% of all cooperative organizations (respectively). These cooperatives employ 24,719 people (data for 1163 reporting co-operatives in 2008) and own capital of 6.4 billion dirham. [22].

Morocco leads in microcredit in the Arab world. The Moroccan microfinance sector represents 40 percent of all microfinance clients across the region, 80 percent of branches, and 50 percent of MFI employment [23], for a share of Arab World population of 10 percent. The Moroccan microcredit sector consists of 13 not-for-profit associations (Associations de Micro Credit - AMC) with some 800,000 accounts and outstanding loans of MAD 5 billion (0.4% of GDP; 0.7% of credit to the private sector) [24]. The four largest AMCs account for 95 percent of the outstanding loans, and the five smallest, 1 percent. With AMCs prohibited from collecting deposits, liabilities are 80 percent bank lines, 15 percent subsidized refinance facility for the ones not fulfilling bank lending conditions (through Jaida – a private fund aimed at refinancing MFIs), plus government and donor funds. In 2010, the sector's equity/asset ratio was 25 percent and its return on equity.

The Microcredit Law of 1999 provided a framework for the nascent industry to take off. The law established Jaida and attracted equity support from international donors. Government sources (e.g., Fonds Hassan II) also contributed equity during take-off. In just four years, from 2003 to 2007, MFI loan portfolios grew 11 times and outreach four times, to 1.2 million accounts (Consultative Group to Assist the Poor – CGAP 2010). Growth was driven by four leading MFIs (Zakoura, Al-Amana, Fondation des Banques Populaires (FBP), Fondep) with 90% client outreach. With the emergence of socially systemic AMCs, oversight responsibilities shifted from the Ministry of Finance to BAM, which started to supervise the sector in 2007, although the Ministry retained licensing power until 2012 [23].

In November 2014, Morocco adopted a new law concerning Islamic finance. This law will participate in the development of Islamic microfinance, which can also benefit from another law adopted by the Moroccan government in December 2014, concerning the reform and development of the cooperative sector.

The Moroccan cooperative sector counts 13,822 cooperatives and unions of cooperatives with 461,878 members (as of december, 31st 2014), divided into twenty sectors and involved in hundreds of industries. However, there is a large imbalance between those sectors, as three of them represent almost 90% of all cooperative organizations: agriculture, crafts and habitat with, respectively, 66.7%, 15.2% and 8.1%. These cooperatives employ 24,719 people (data for 1163 reporting cooperatives in 2008) and own a capital of 6.4 billion dirhams, see [22].

In the following, we will present a proposed model in order to simulate the importance of cooperatives using a Takaful system. We use for the modeling an Agent based simulation, which is adapted to this problem due to its complexity and the large number of "interactions". For more details about the Agent Based Simulations on mutliagent system and also its application in finance and islamic microfinance, we can see [8], [9], [10], [11], [12] and [25].

5. MODEL DESCRIPTION

In this paper, we try, to some extent, to assess the efficiency of cooperative system. In order to replicate what is done in real life, we create a cooperative reserve called Takaful reserve that is fed by the contribution of cooperative agents from the gain in capital each year. This reserve allows to reimburse the debt of agents when there is a credit default toward the MFI.

In attempt to highlight the benefits of the proposed model, from a macroeconomic point of view, we consider a society of low-income agents where each agent has the following properties:

- An initial wealth w (uniformly distributed)
- The probability of moving inside the society (constant for all agent)
- The probability of joining an existing cooperative in a neighbourhood (constant for all agent)
- The proportion of profit to put in the Takaful reserve each year (constant for all agents)
- An activity (the investment area is uniformly chosen for each agent)

We consider also that the performance of agents' projects is distributed according to a normal distribution with mean m and standard deviation σ presented as parameters in the user interface.

The Microfinance Institution has the following input parameters:

- An initial wealth.
- The maximum amount to provide to each agent.
- The financing cost composed from a base cost and variable cost. The Microfinance Institution provides funds to agents according to their needs; the financing cost depends on two parameters:
- Wealth of each agent (independent parameter) : W
- Debt of each agent (independent parameter) : D
- Takaful reserve of each agent (relative parameter) : T
- Financing-cost = base-cost + $\beta \times$ variable-cost

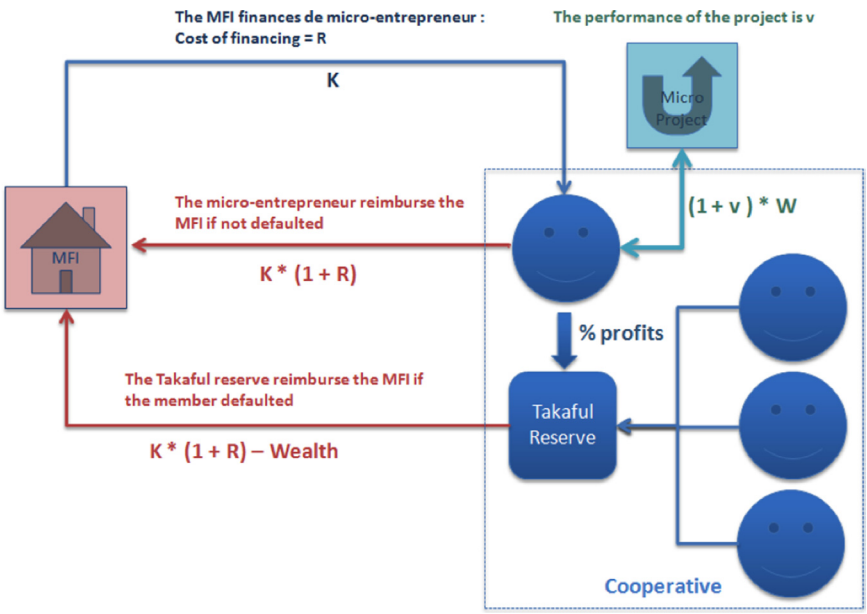
Where $\beta = 1 - (W - D + T)/\text{borrowed-amount}$

Thus, the higher the Takaful reserve and the wealth of each agent, the lower is the MFI financing cost.

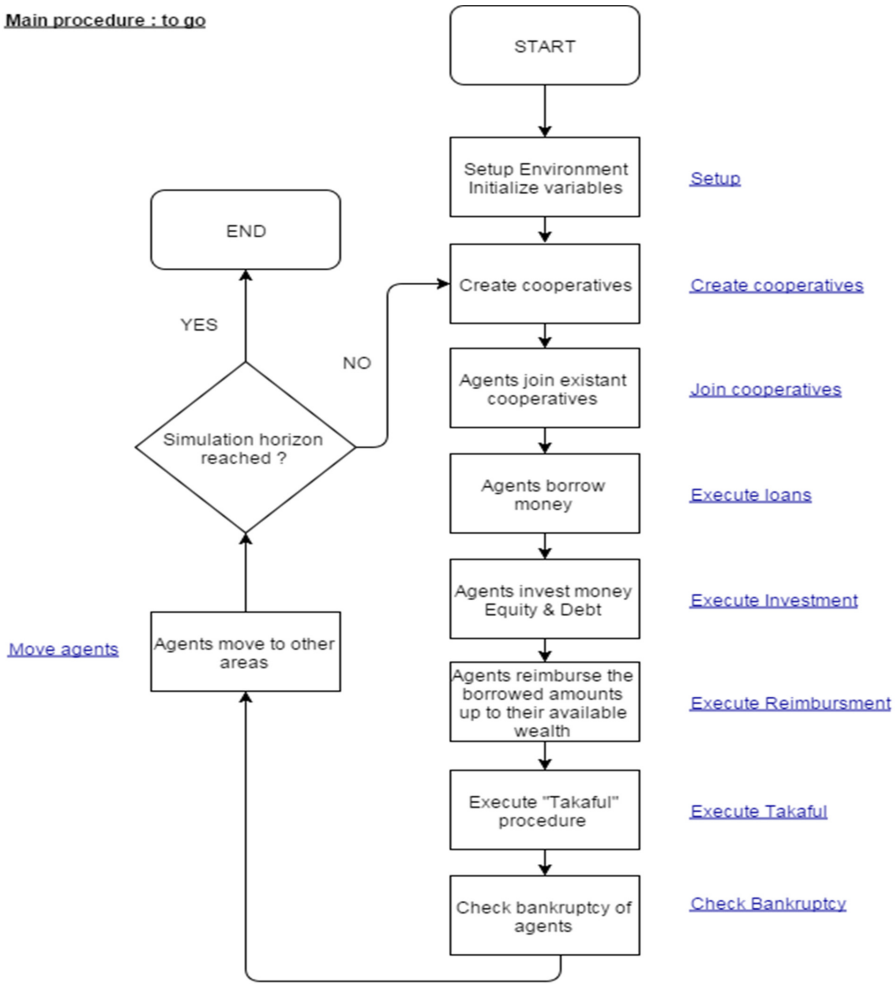
The above model, is implemented using NetLogo, an agent-based environment. The agents are modelled as turtles on a landscape. Each agent has an initial wealth and launches a project in a given area, the financing can be totally or partially provided by the MFI.

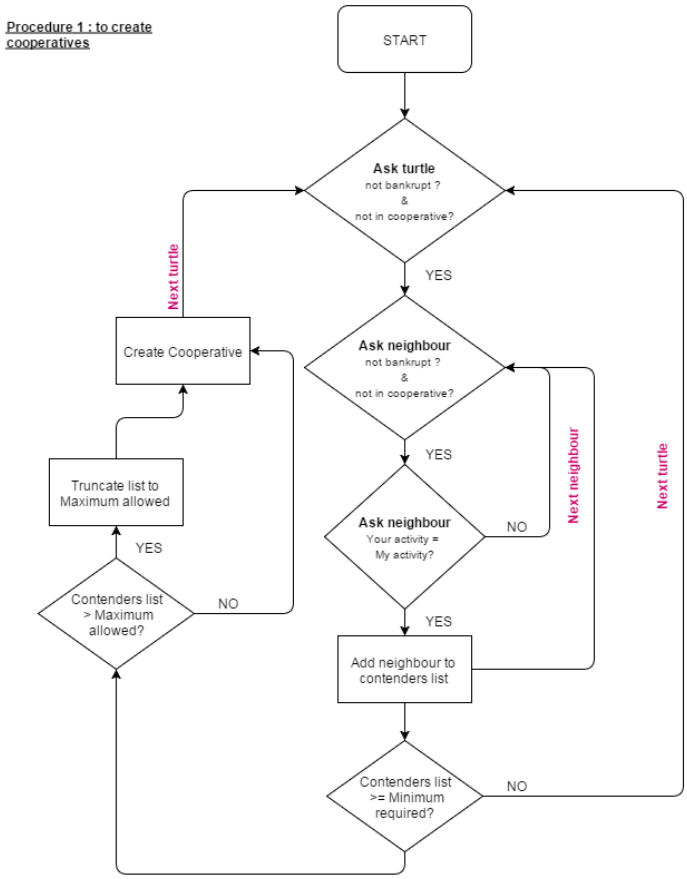
Each period, every agent can move randomly inside the society seeking opportunities to create a cooperative with his neighbours (if they have the same activity area) or to join an existing cooperative (should he have to the same activity as the existing cooperative). The number of members of each cooperative should be between the Min-members and Max-members which are input parameters. Each period, the wealth of the agents and the MFI are updated according to the occurred cash-flows (Cf. figure above).

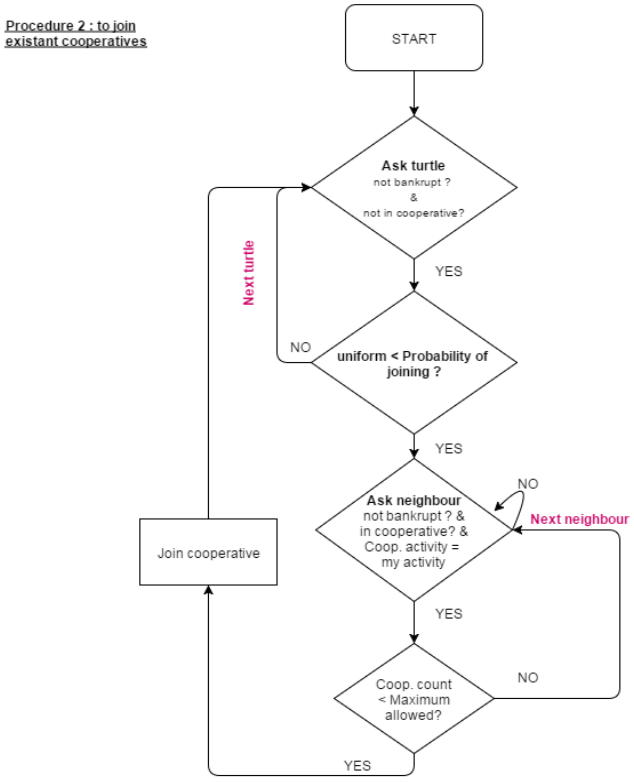
Bankruptcy occurs when, at the end of a period, the agent is not able to reimburse the MFI, it would reset all variables to zero, and the bankrupt agent is out of the economy.

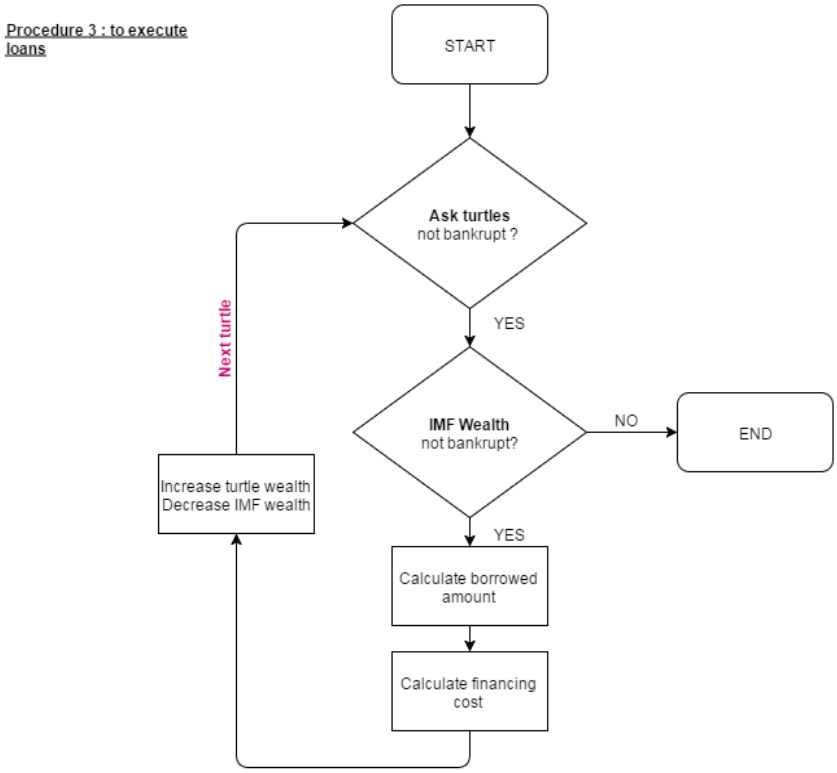


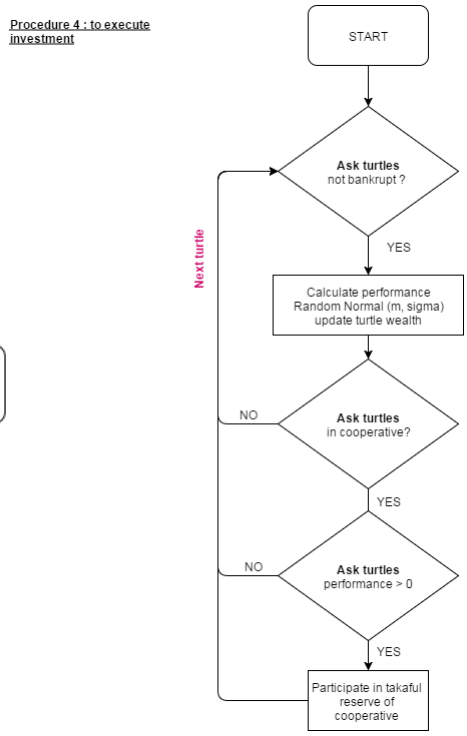
5.1. Program Chart Flow

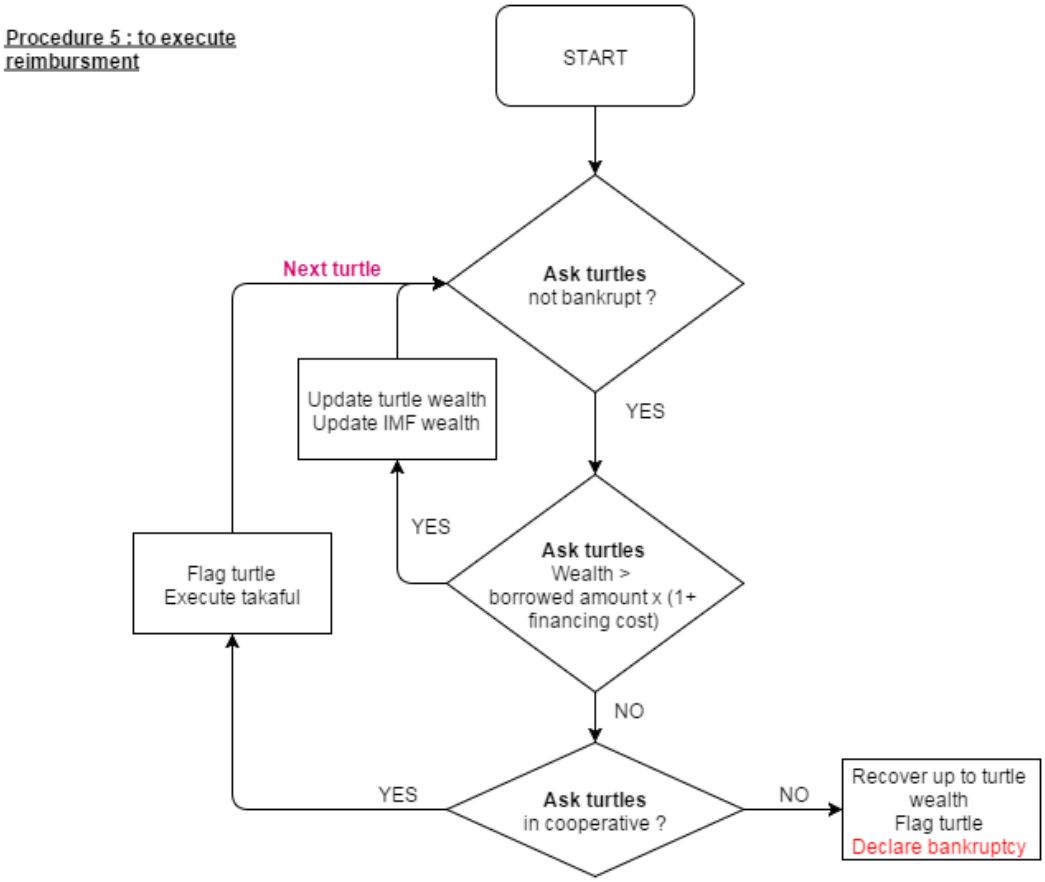


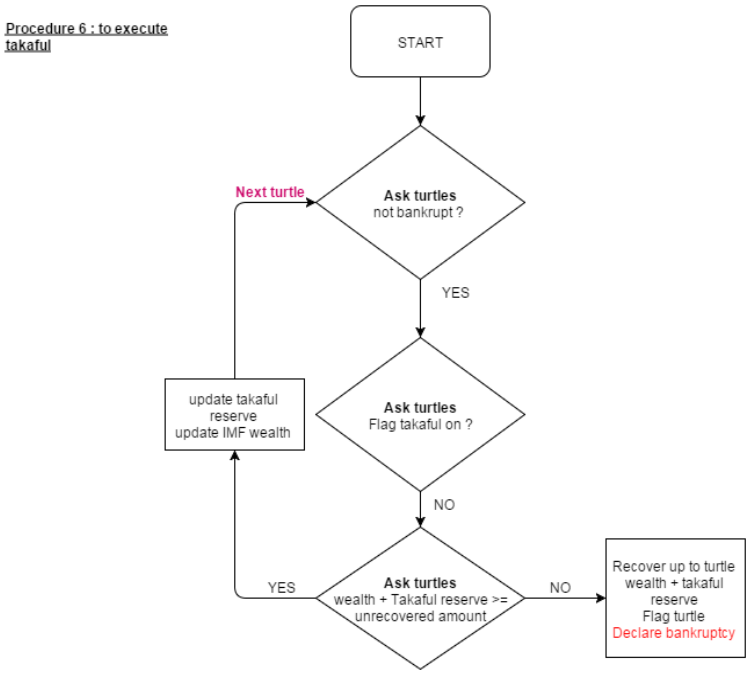

Procedure 1 : to create cooperatives
START
Ask turtle
not bankrupt ?
&
not in cooperative?
YES
Next turtle
Create Cooperative
Ask neighbour
not bankrupt ?
&
not in cooperative?
YES
Next neighbour
Next turtle
Truncate list to Maximum allowed
Ask neighbour
Your activity =
My activity?
NO
YES
Contenders list > Maximum allowed?
NO
YES
Add neighbour to contenders list
Contenders list >= Minimum required?
NO

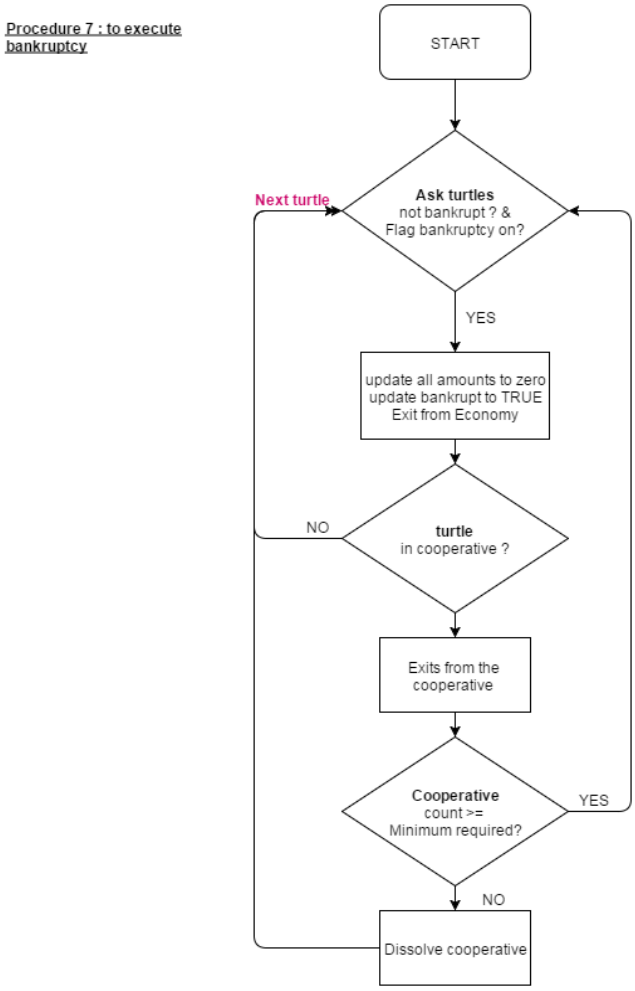

Procedure 2 : to join existant cooperatives
START
Ask turtle
not bankrupt ?
&
not in cooperative?
YES
Next turtle
NO
uniform < Probability of joining ?
YES
NO
Ask neighbour
not bankrupt ? &
in cooperative? &
Coop. activity =
my activity
Next neighbour
YES
Coop. count < Maximum allowed?
NO
Join cooperative
YES


Procedure 3 : to execute loans
START
Ask turtles not bankrupt ?
YES
IMF Wealth not bankrupt?
NO
END
YES
Calculate borrowed amount
Calculate financing cost
Increase turtle wealth
Decrease IMF wealth
Next turtle


Procedure 4 : to execute investment
START
Ask turtles not bankrupt ?
YES
Calculate performance
Random Normal (m, sigma)
update turtle wealth
NO
Ask turtles in cooperative?
YES
NO
Ask turtles performance > 0
YES
Participate in takaful reserve of cooperative
Next turtle


Procedure 5 : to execute reimbursment
START
Next turtle
Ask turtles not bankrupt ?
YES
Update turtle wealth
Update IMF wealth
YES
Ask turtles Wealth > borrowed amount x (1+ financing cost)
Flag turtle
Execute takaful
NO
YES
Ask turtles in cooperative ?
NO
Recover up to turtle wealth
Flag turtle
Declare bankruptcy


Procedure 6 : to execute takaful
START
Ask turtles not bankrupt ?
Next turtle
YES
Ask turtles Flag takaful on ?
update takaful reserve update IMF wealth
NO
Ask turtles wealth + Takaful reserve >= unrecovered amount
YES
NO
Recover up to turtle wealth + takaful reserve Flag turtle Declare bankruptcy


Procedure 7 : to execute bankruptcy
START
Ask turtles not bankrupt ? & Flag bankruptcy on?
Next turtle
YES
update all amounts to zero update bankrupt to TRUE Exit from Economy
turtle in cooperative ?
NO
Exits from the cooperative
Cooperative count >= Minimum required?
YES
NO
Dissolve cooperative

5.2. Program Description

5.2.1. Input Parameters

These global parameters are set by user in NetLogo interface:

- Poor-population is used to set the number of the agent in the society.
- Number-of-activities is used to set the number of existing investment area in the society.
- Simulation-duration is used to set the duration of simulation.
- Initial-current-wealth is used to set the initial wealth of the MFI.
- Amount-per-loan is used to set maximum financing amount.
- Base-cost is used to set the base cost of financing.
- Variable-cost is used to set the variable cost of financing.
- Moving-probability is used to set the probability of moving inside the society of each agent.
- Joining-probability is used to set the probability of joining an existing cooperative in the neighbourhood.
- Reserve-proportion is used to set the percentage of profit to allow to the Takaful reserve.
- Initial-wealth is used to set the maximum of the uniformly distributed wealth.
- Debt-limit is used to set the debt limit for each period (when set to zero, it means that, when defaulted an agent cannot ask again for financing from the MFI, therefore debt growth is no more possible).
- Performance-mean is used to set the mean of the investment performance normal distribution.
- Performance-std-dev is used to set the standard deviation of the investment performance normal distributions.
- Min-members is used to set the minimum number of members for each cooperative.
- Max-members is used to set the maximum number of members for each cooperative.

5.2.2. Global Variables

- Imf-current-wealth is the current wealth of the MFI.
- Sum-loans is the sum of all the funds provided by the MFI (is used to check the consistency of the simulation).
- Sum-reimbursements is the sum of all the reimbursements perceived by the MFI (is used to calculate the current wealth of the MFI).
- Sum-takaful-reimbursements is the sum of all the reimbursements provided by Takaful reserves (is used to check the consistency of the simulation).
- Created-wealth is the sum of all created wealth due to the investments (is used to check the consistency of the simulation).

- Initial-global-wealth used to check the consistency of the simulation.
- Sum-bankrupt-debt is the sum of all the outstanding debts (is used to check the consistency of the simulation).
- Cooperative-size-list, cooperative-reserve-list and cooperative-size-sublist are used to perform some cooperative operations such as Joining cooperative.
- Defaulted-agent-list is the list of all defaulted agents.
- Gini-index-reserve used to plot the Gini index.
- Lorenz-points used to plot Lorenz Curve.

5.2.3. Agent Variables

- Borrowed-amount is the borrowed amount from the MFI.
- Individual-debt is the amount of debt of the agent.
- Individual-wealth is the current wealth of the agent.
- Takaful-reserve is the proportion of fund allowed to the Takaful reserve.
- In-cooperative? is used to determine if the agent belongs to a cooperative or not.
- Was-in-cooperative? is used to determine if the agent has already been in a cooperative or not.
- Cooperative-id is the Id of the cooperative to which the agent belongs.
- Cooperative-size is the size of the cooperative to which the agent belongs.
- Activity is the investment area of the agent.
- Bankruptcy is used to determine if agent is defaulted or not.
- Effective-financing-cost is the effective financing cost according to the financial situation of the agent (calculated using the base-cost, variables-cost and financial situation of the agent).
- β is a technical variable used in the calculation of the Effective-financing-cost.
- Flag-borrow is used to determine if an agent has already borrowed money from the MFI.

5.2.4. Procedures

- To setup: used to initialize all the agent and global variables according to the input parameters.
- To go: stops if the MFI is going bankrupt

  Step 1. Call procedure create-cooperatives

  Step 2. Call procedure join-cooperatives

  Step 3. Call procedure loan-calculate-perf

  Step 4. Call procedure execute-reimbursement

  Step 5. Call procedure execute-takaful

Step 6. Call procedure bankrupt

Step 7. Call procedure calculate-mfi-wealth

Step 8. Call procedure update-lorenz-and-gini

Step 9. Call procedure move-agents

Step 10. Reset and Tick

- To create-cooperatives: each agent Looks for neighbours having the same activity, if there is more than the minimum number required to create a cooperative, a cooperative would be created.
- To join-cooperatives: Look for existing cooperative in the neighbourhood, if there is one having a size less than the maximum authorized , the agent would join.
- To loan-calculate-perf: The MFI funds the project and calculates the financing cost based on the agent wealth and the Takaful reserve if he belongs to a cooperative. The wealth of the agent is updated according to the performance of the project.
- To execute-reimbursement: The agent reimburses the MFI and the wealth is updated. If the agent cannot reimburse the MFI he is declared bankrupt and will be out of the economy.
- To execute-takaful: If the agent belong to a cooperative and cannot reimburse, the Takaful reserve will reimburse the difference.
- To bankrupt: If the agent wealth is inferior to zero he is going bankrupt and if he belongs to a cooperative which it's number of members is equal to the minimum required the cooperative is dissolved.
- To calculate-mfi-wealth: Calculates the wealth of the MFI.
- To update-lorenz-and-gini: Plots the Gini index and Lorenz Curve.
- To move-agents: At the end of the period if the agent is individual he moves to a random empty position in the society.

5.3. Outputs

Different outputs are displayed in this program. First, we try to assess the profitability of the micro finance institution by displaying its global worth in respect to time. This quantity recalculated as an annual IRR allows to measure the performance of the institution and the viability of its business model. Obviously, an IRR less than its financing cost (generally around 3%) would be redhibitory, but a low IRR even greater than the financing would still be rejected due to the opportunity cost.

Secondly, we measure the global wealth created by the MFI, and we focus especially on the distribution of wealth through the different households. We plot a histogram of wealth, and calculate the mean, standard deviation and the asymmetry of the distribution.

The third output is the Lorenz curve which is a graphical representation of the cumulative distribution function of the empirical probability distribution of wealth. This curve is plotted with the first bisectrix ($y = x$) in the same chart, so one can visualize the difference between the two curves. The closest the curves are, the best is the distribution of wealth between agents.

The last output of these simulations is the Gini index which measures the inequality among values of a frequency distribution (in our case, wealth of agents), a Gini index of zero expresses perfect equality, while a Gini coefficient of one expresses maximal inequality among values.

6. SIMULATION RESULTS

Several simulations have been performed to understand the relationship between the different parameters.

The outputs can be read from two different perspectives: The MFI perspective which is mainly focused on profitablity which implies perennity, and then from the agents point view that is basically, funding their projects, getting rid of poverty and dipatching the wealth fairly.

7.1. From the Perspective of the Microfinance Institution

Let us consider the first perspective which is that of the MFI.

We consider a pool of a large number of low-income people, having an average initial wealth of $100, and working on 3 different activities. No cooperation is created. These poor people borrow money from the MFI to complete an investment amount of $1000.

We assume that the initial wealth of the MFI is $1,000,000 and that the financing base cost is *r*. No variable cost is applied.

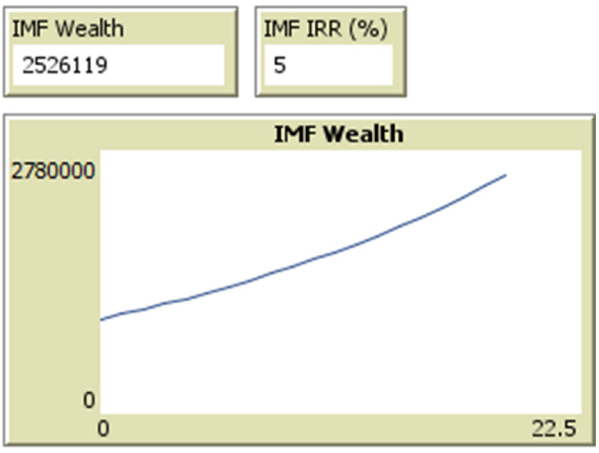
The investments made by the agents have a mean performance of μ and a standard deviation σ.

The perennity of the MFI institution depends strongly on the performance and the risk of underlying projects invested by agents. We have noticed that when these projects deliver low performances or are very risky, the entire population goes bankrupt one day or the other and can not afford the reimbursement of their loans.

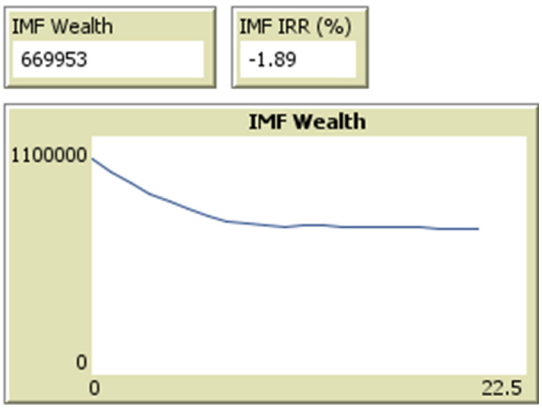
In the two basic cases below, one can notice the importance of both risk and performance of the projects.

Case 1: No underlying risk $\sigma = 0$, and financing cost equals projects performance $r = \mu$.

For a 20 years simulation, the MFI realized a 5% IRR, as all people realize the same performance and reimburse the loan with probability of 1.



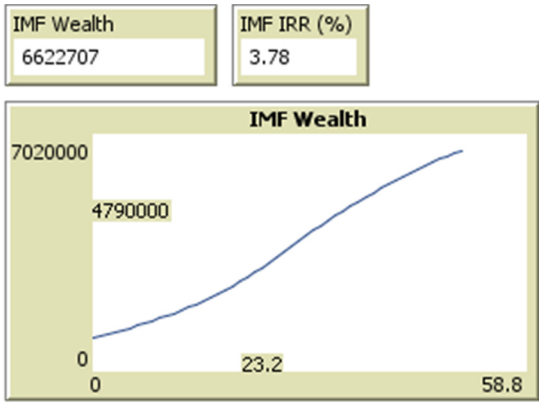
Case 2: The projects deliver high performance $\mu = 8\%$ versus financing cost $r = 5\%$, but the projects are very risky $\sigma = 30\%$. In this case, the MFI will lose money after 20 years and end with a negative IRR.



This means that the MFI should choose the projects it is able to finance with precaution, and calibrate its financing cost so that it can guarantee a certain perennity without applying high costs to poor people.

Another important point from the perspective of the MFI is the volume of the market and the period of activity within the same market. We have noticed, that when the MFI stays too long targeting the same market, its IRR decreases significantly in the last years. This is due to the fact that people having access to the microcredit in the first years, reach a certain level of wealth and will not be eligible to take loans, this leads to a decrease in the IRR as money in not invested by the MFI. This is an ideal situation, because, the MFI, in general, does not have enough resources to fund all the available projects, and when some people reach the threshold, they leave the place to other poor to take advantage of this market tool.

Just for the sake of illustration, we present the idea above in this case, where the parameters are all the same as those of case 1, but the simulation is turned for 50 years.

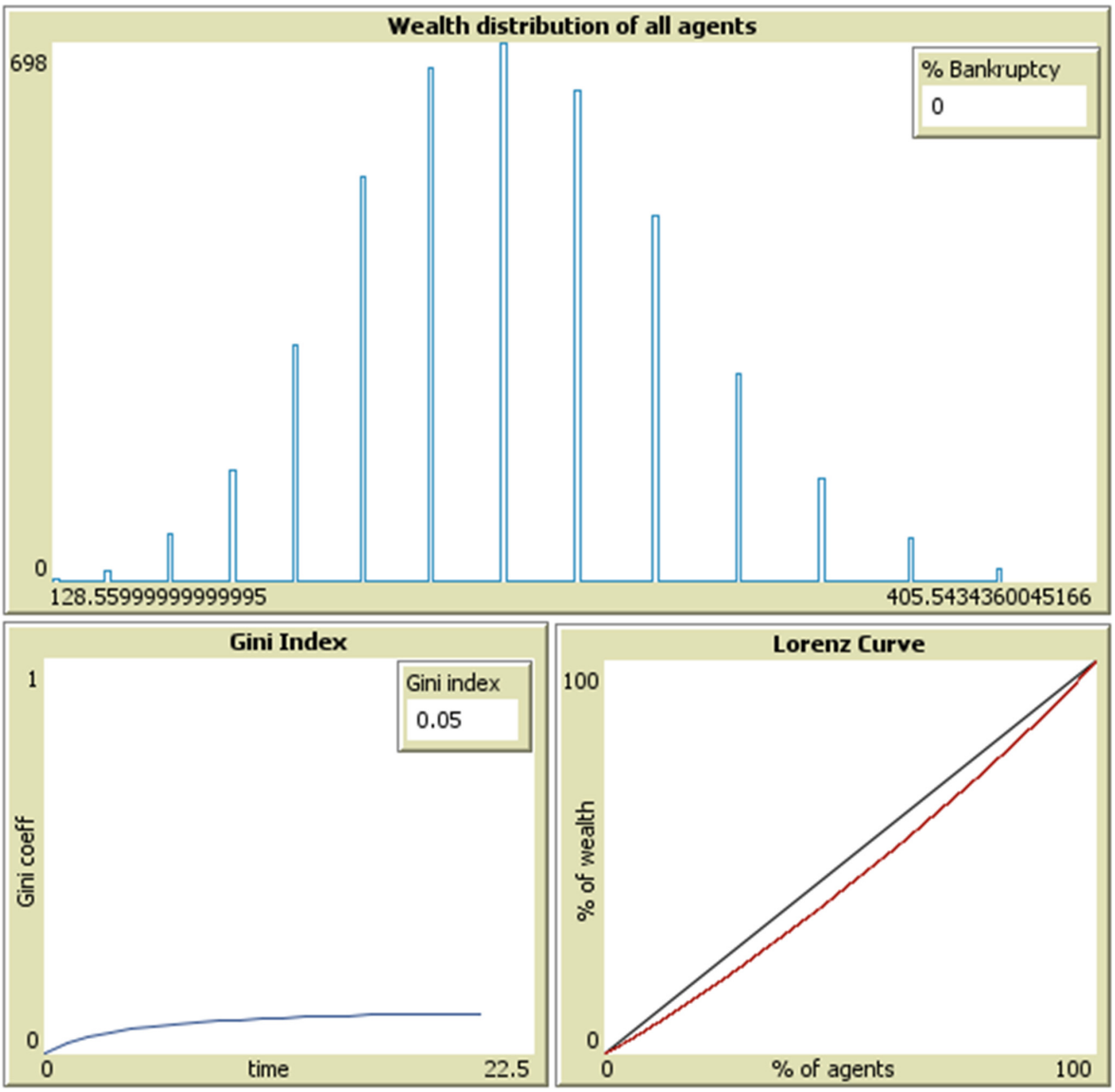


7.2 From the Perspective of the MFI Customers

7.2.1. Without Cooperatives

Case 1: In this case, we assume that the investments have no risk $\sigma = 0$, that they deliver a performance of $\mu = 5\%$ and that the financing cost is equal to $r = 4\%$.

This leads to a very health situation, where all individuals get performance, no one is going bankrupt, and the money is barely uniformly distributed between agents (Gini index close to zero and the Lorenz Curve is exhibiting very close curves).

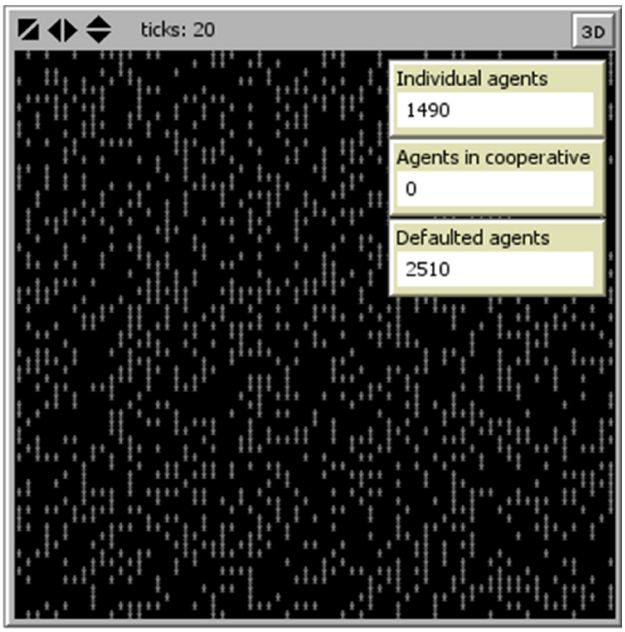


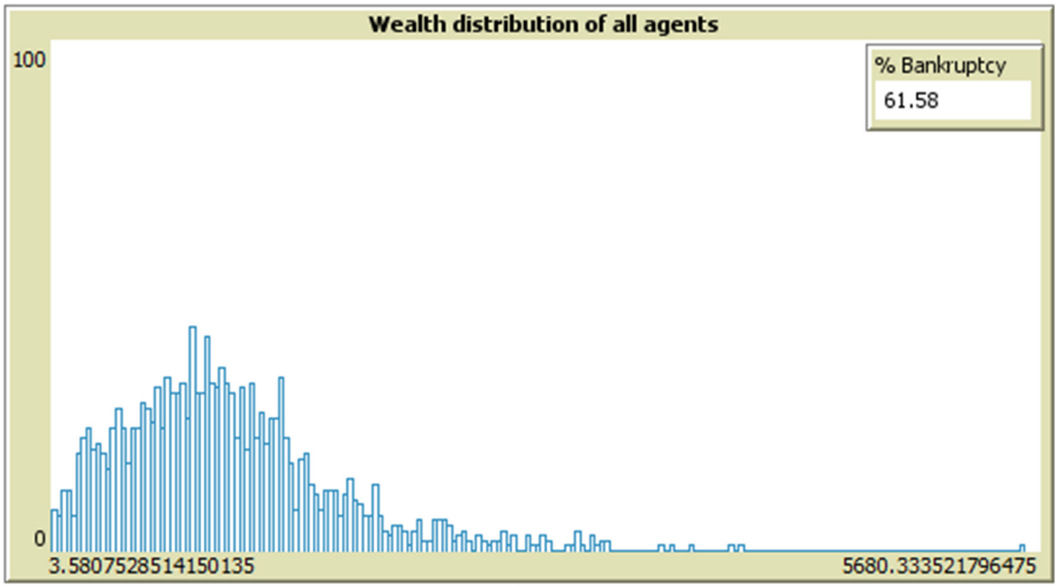
The fact that the gain is not the same for all agents, is because, some of them get funded the first years, whereas others wait for their turn. It is to be noted, that the agents borrow only the remaining amount to their investment ticket, thus, they only pay the financing cost on the prorata.

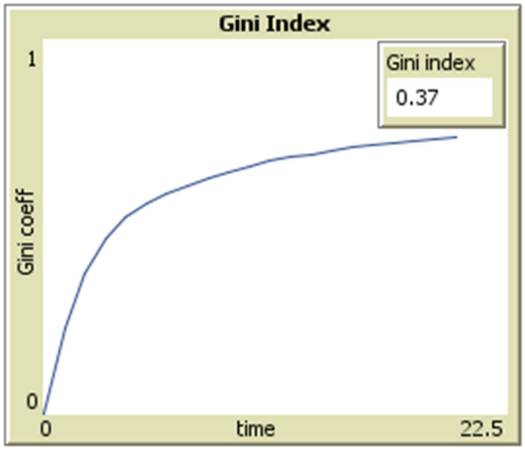
Case 2: In this case, we assume that the investments have moderate risk $\sigma = 15\%$, that they deliver a performance of $\mu = 5\%$ and that the financing cost is equal to $r = 4\%$.

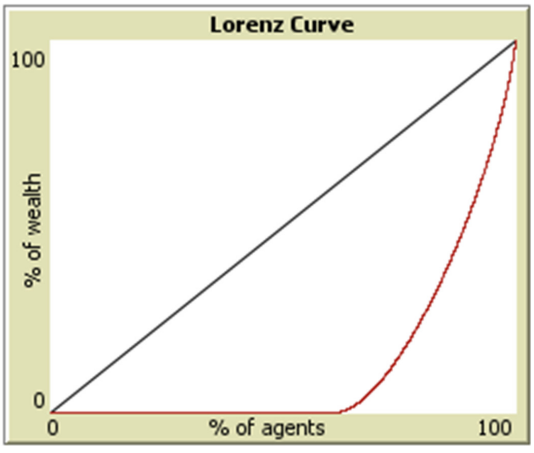
This leads to a bukruptcy rate above 60%, and a great disparity of the wealth distribution.

The large risk of projects, leads to a devastating result, and even if the financing cost decreases to 2% or 3%, we still remain with half of the population going bankrupt.


ticks: 20
3D
Individual agents
1490
Agents in cooperative
0
Defaulted agents
2510


Wealth distribution of all agents
100
0
% Bankruptcy
61.58
3.5807528514150135
5680.333521796475

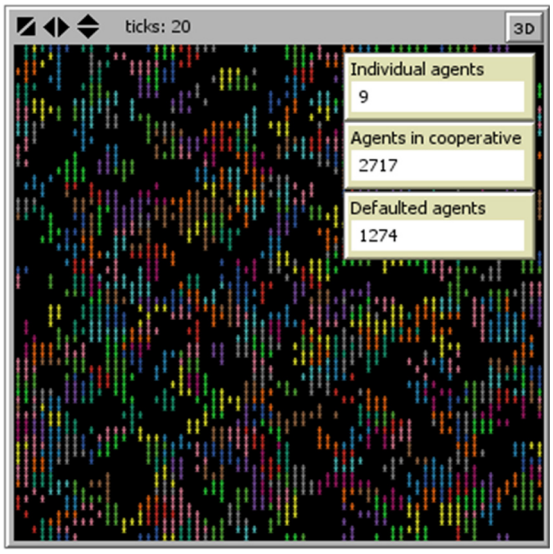

Gini Index
1
0
Gini index
0.37
Gini coeff
0
time
22.5

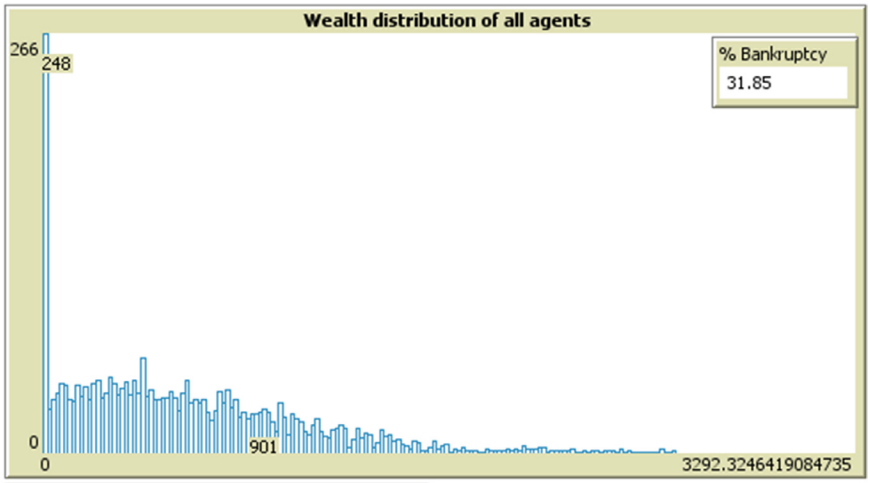

Lorenz Curve
100
0
% of wealth
0
% of agents
100

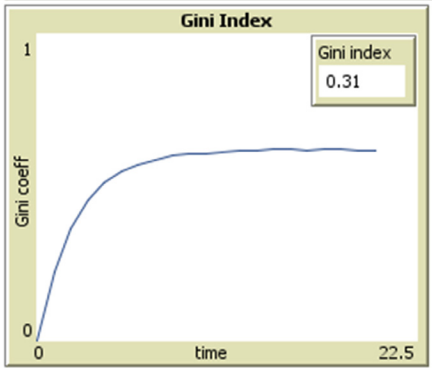
6.2.2 With Cooperatives

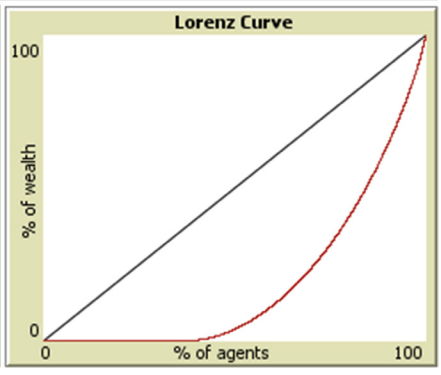
Case 3: Let consider, that people can create cooperatives with members between 4 and 6, and that 10% of the gain is gathered in a reserve called Takaful reserve, which will serve to recover the payment of defaulted projects.

We assume a high risk environment, the same as the previous one.



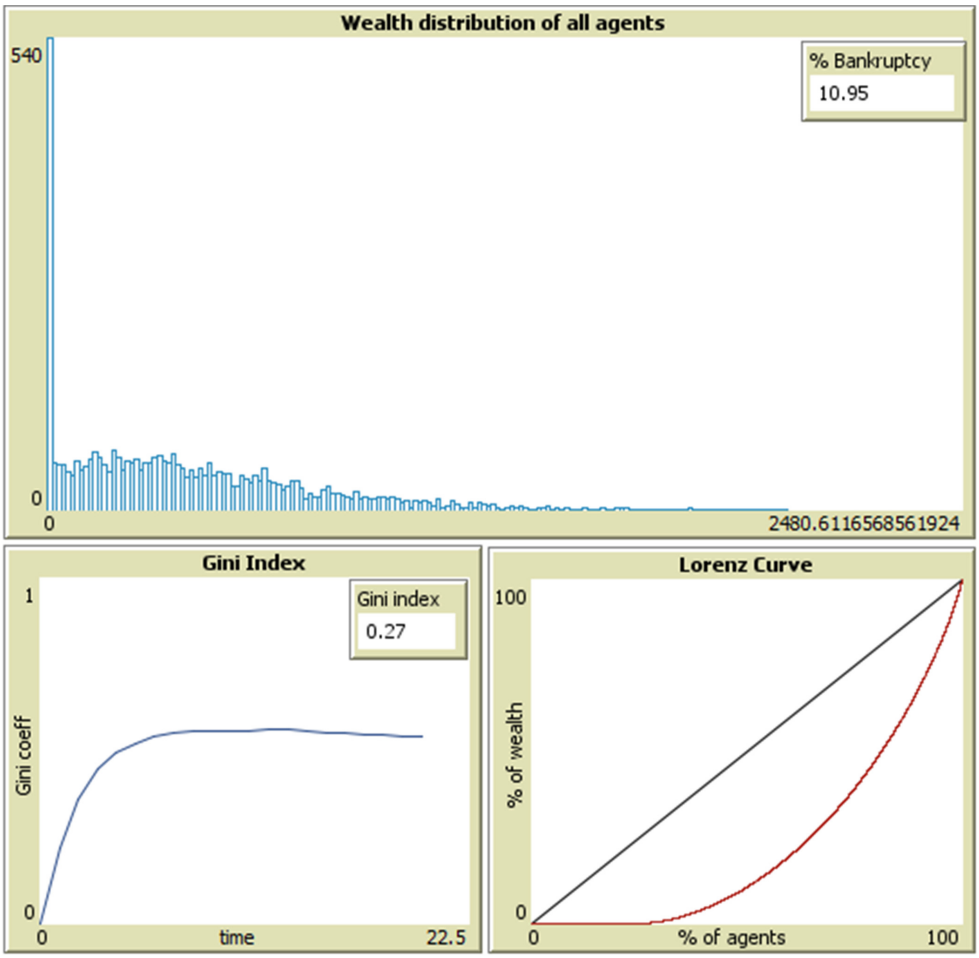






We notice that the barkruptcy rate has decreased by half, but the distribution of the wealth was not enhanced significantly.

This is due to the low proportion of the wealth put into the Takaful reserve. In the charts below, the Takaful reserve proportion is raised to 30%.



7. CONCLUSION

This paper proposes a first approach for low-income population to take profit from the tricky world of financing despite their low creditworthiness and their lack of guarantees.

In fact, cooperatives allow this category of people to enhance their creditworthiness by diversifying the risk and pooling money to recover the defaults of their colleagues.

However, One should keep in mind that many complications occur in the real world, especially in the consitution of the Takaful reserve and this simple version of this model does not take them in consideration. As an extension to this article, we will build a more sophisticated model, that calculates the "fair" proportion to put in the common reserve based on a creditworthiness score in order to eliminate frustration factor towards "repeat" losers and large risk takers. The model will also be calibrated based on real parameters calculated on the Moroccan case.

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