

Microcredit project

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Simulation models for economics

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1 Introduction

The general topic of this project refers to a Microcredit program, which consists of a financial provision to individuals whose economic and social status makes them unable to ask for loans to the usual agents of the credit market (banks). The first idea of Microfinance dates back to the 70s, his founding father was a Bangladeshi economist, Mohammad Yunus. From this start point onwards many economic actors in the world focused on the role of Microfinance, and several governments, especially belonging to developing countries, adopted these strategies to relief from poverty and extreme poverty many social groups. In particular, this project will focus on a special program adopted by the Brazilian Government in 2003, named Bolsa Familia Program (BFP).

This political and economic measure unified some previous programs of cash transfer, regarding Education and Alimentation sectors, among others. By January 2005, it was supposed to cover 26.4 millions of people, later this level has been reached and also exceeded, with an extension of the program to about 44 million people (11.2 million families), mostly placed in the North-East region of the country and two thirds of which were extremely poor. BFP consisted of conditional cash transfers, these lasts are provided to the families as socio-economic agents, not individually, and preferably to the women. There exist mainly three duties for the transfer recipients: school attendance for children aged between 7 and 16, always children up to 6 years old must get vaccinations according to the Ministerial calendar and women in pregnancy and children in childbearing age have to undertake mandatory medical exams at health-care assistance centers. Hence this BFP is a “social contract” between the Government and the beneficiaries, aimed to strengthen women emancipation, and consequently their bargaining power in the family (since the mothers are

those who manage the money) and lastly to increase the human capital . It is an investment for the future, and particularly for the poorest families investment in human capital is a condition sine qua non for the transfer. As it is guessable above, the Program targets two groups in the Brazilian society, the extremely poor and the moderately poor. To the former one belong those families with a per capita income worth less than 17 \$ per month, whereas are part of the last group those households with a per capita income calculated between 17 \$ and 34 \$.

The positive effects of such a program affect both social and economic sector, other than the political one. Social consequences and economic ones are intertwined. The formers are an increase of school attendance, so an higher probability to finish primary school and owning a minimum level of instruction, the higher this level will be, the higher will be the income gained by the individual (economic consequence). Another social aspect is the decreased number of children with diseases that impede the presence at school and their learning ability, threatening their future, this thanks to vaccinations programs run by the government. Less health expenses burden to the family means more money to be destined to consumption or investment.

Negative effects of BFP to be taken into account refer to the possibility of refusing job offers from certain recipients who are afraid to lose the subsidy (in case the new revenue is higher than the threshold that entitles a worker to get the subsidy). Hence there exists a problem of incentives to work, but here comes a choice that is up to the government: whether to choose for an instantaneous increase in the employment rate, although under the condition of low salary and bad work conditions, or to keep going on with the project of financial provision with a long-term prospective, so as to pull out of poverty an entire share

of population. Choosing the second alternative means to accept at the beginning some risks , and only expenses, no gains for state budget.

2 The NetLogo Simulation

2.1 Setup of the world

The goal is to create a simulation of the Bolsa Familia Program, that summarizes the dynamics of families asking for loans, and consequently the outcomes achieved. The simulation starts with an observer (whether the government or more in general the market) and the others types of components of the model: turtles, patches and links. On the first and only one patch, characterized by color white, that we intend as the social world where BFP will be implemented, are present several turtles, each one representing a group of individuals, known to the observer and to the rest of the world as a family. The agents compose the families, the total number of agents in the world is set by the slider `n_of_individuals`, whose range is (0,100). The number of families is derived from an uniformed distribution, so it is casual. The members of each family, called agents, can vary from 1 to 10. Among these agents inside each family the proportion of men and women is exactly the same (50 %). We distinguish these families in the Code by assigning them a variable (number) through the counter `family_counter` . Agents in the families are characterized from the beginning by a series of behavioral aspects that result crucial determinants in the screening activity of the Fund provider to decide whether to assign or not the cash transfers and to whom. A condition sine qua non to receive the loans is that the years of instruction (*yearseducation*) are greater than a minimum level of education, set by a slider (*minimumeducation*) which can vary according to our will between 10 and 20 years. The years of instruction in turn are determined by a variable whose value is random in a range between the slider `instructionBasis` and 20. The condition to

receive microcredit is highlighted in the following part of the code, included in a cycle while at the beginning of command go, the one which includes all microcredit actions.

```
to go

  let loan 50

  let counter family_counter

  let k 0

  let yeareducation instructionBasis + random 20

  let sons nofsons

  while [counter > 0]

    [set k k + 1

     ask persons with [family = k] [

       if yeareducation > minimumeducation

         [set ycor ycor + 1

          set loan ( loan - 1 )]

          set counter counter - 1

        ]

    ]]
```

After the program implementation, agents are endowed with a determinate quantity of funds, the latter decreases as they start their business by 1 unit for men and by 2 for women. Earnings of women and men can differ, they are determined respectively by the two sliders *womentendencybusiness* and *mentendencybusiness* that vary in a range (1, 3).

2.2 Agents' economic choices

The earnings obtained during their business activity are spent in four possible ways :

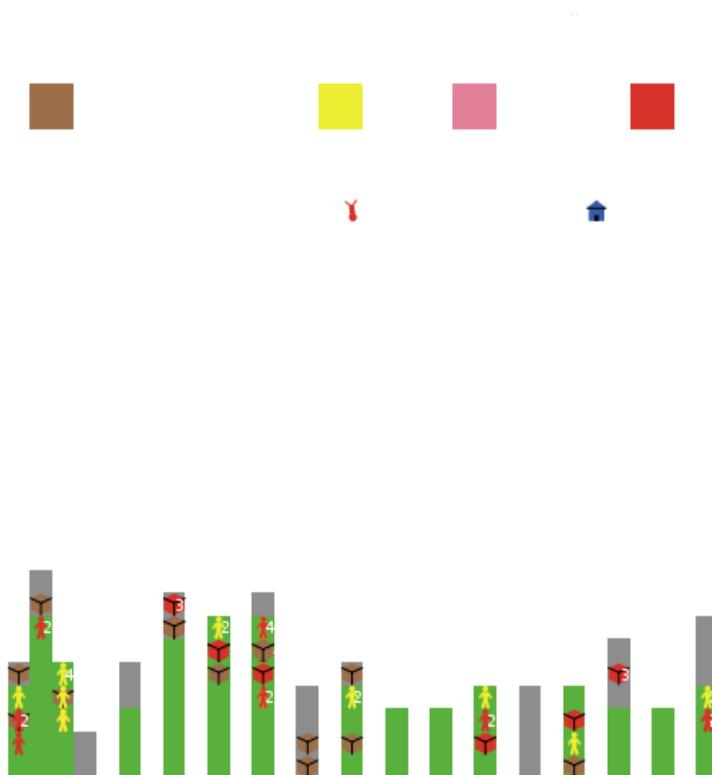
- 1) Education expenses for children
- 2) Medical expenses
- 3) Leisure time activities
- 4) Well-being (this money destination underlines the particular condition according to which women spend their money exclusively for their own interests)

These ways are represented in the Interface through four colored boxes on the top of the screen. According to these possible choices agents take a determinate color to which is assigned one money destination: yellow (1) , red (2) , brown (3) , pink (4) . The portion of agents spending their money in the different activities just mentioned is determined by a lot of variables: the number of sons, a certain number of years of education, a determinate level of earnings. The number of sons (*noFsons*) is chosen with a slider command, hence the observer can vary it between 0 and 5.

According to certain established ranged of earnings and to different thresholds of education, agents will spend money gained in the four different activities. In the society we will register some consequences, which can be, depending on the choices, whether an increase or a decrease of school attendance, health condition, leisure time and well-being expenses (that region of the world, like others, is affected by diseases easily treatable with simple vaccinations, hence we hypothesize positive health condition directly proportional to the use of vaccinations and presence to medical visits). The amount of money spent respectively by women and men in leisure time, instruction, health condition and well-being is reported by some monitors in the Interface.

Agents entitled with microcredit loans move upwards in the world, by a unit between 1 and 3 determined by two other sliders, *stepsforwardmen* and *stepsforwardwomen*, per every moment (*tick*). They change the color of patches where they pass so as to mark that business activity has been computed. When men undertook their activities the patches where they are turn from white to grey while where women started their ones patches take on the color green. Here below is reported an example of the world (Fig.1): the four colored boxes located on the top of the image represent the destinations of money expenses. The bottom of the picture is the starting point for all agents who begin their activity. This image reports situation at tick 30 i.e. when the process is finished. From this information we can guess that somebody did not move at all, hence his characteristics from the point of view of education did not meet the necessary criteria to receive any cash transfer. Given this, some men (box shape identifies agents of sex male) and a woman, identifiable behind the brown box at the bottom right of the picture, remained without loans.

Fig. 1



Upon each agent is reported a number which highlights the proportion of earning after implementing the business activity.

A graph in the Interface (Fig. 2) highlights the trend of business activity of men and women in the society.

Fig. 2

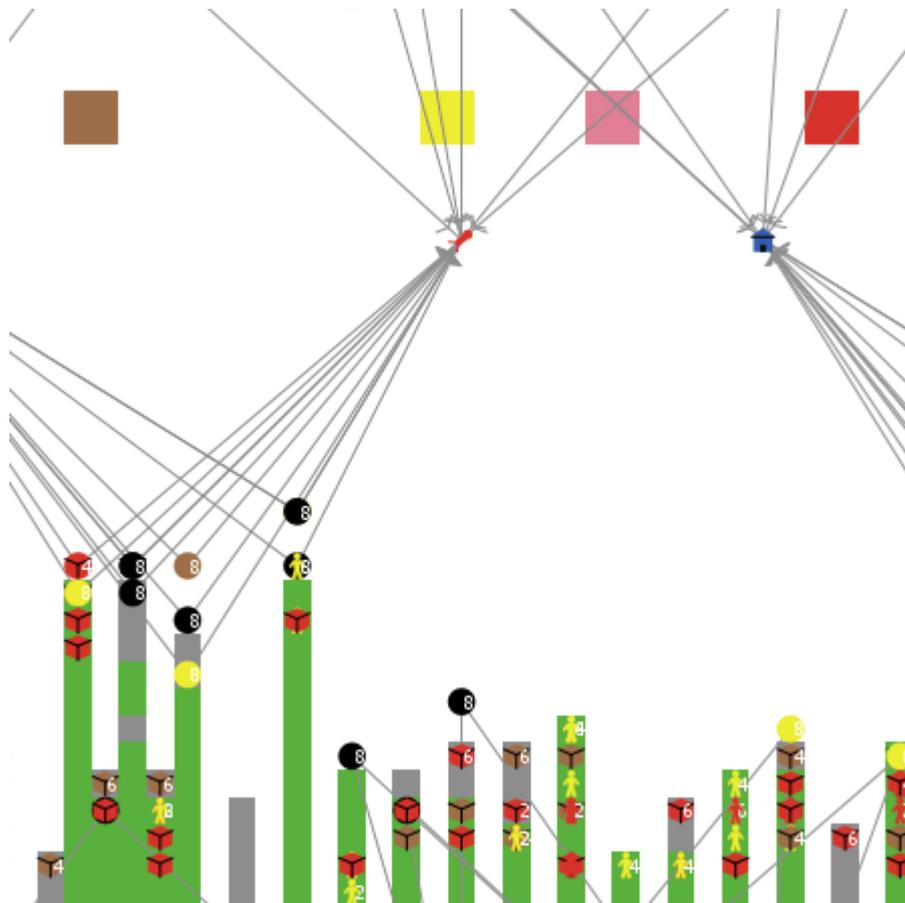


2.3 Insolvency

Two other important determinants of the behavior of agents are reported in the Code as `income` (a variable to which is assigned a slider `revenues`) and `expenses` (a turtle-own variable). The volume of `expenses` is reported in the Interface by two monitors, `Men expenses` and `Women expenses`. `Income` can vary in a pre-established range (0, 20) whereas `expenses` increases every moment (`tick`) by an amount equal to half of the earnings gained each moment. After a certain period of activity exists the possibility that the level of `expenses` exceeds `income`, if this occurs, the agents become insolvent (we assume they cannot refinance themselves through the Microcredit loan them provided, since it is aimed exclusively to the business activity, not thought as repayment fund). In the condition of insolvency they will recur to an `usurer` to solve their financial problems. In the Interface the insolvent agents are recognizable by their "circle" shape and the relation

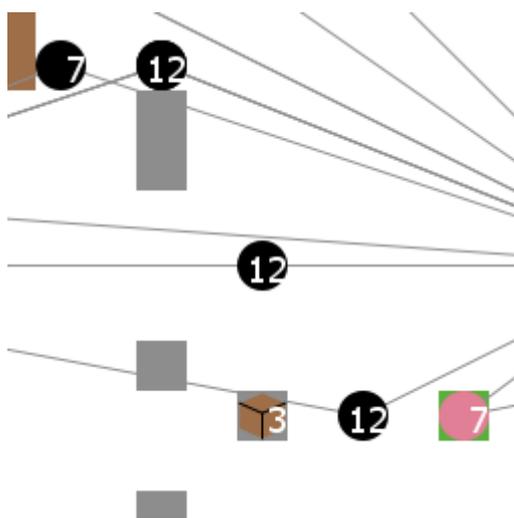
with the `userer` is highlighted by a link. The latter is a new breed that assumes in the shape of a red “bug “. It is noticeable at the top center of the picture reported below (Fig. 3), where the `userer` is connected with the insolvent agents by a bond that in Netlogo is interpreted by a link . All insolvent agents assume the “circle” shape , they can change color according to which was the destination of their expenses when they got bankruptcy. We will see later what represents black color and the other links on the right side of the picture.

Fig. 3



The insolvent agent faces two possible actions : revealing his relation with the `usurer` or remaining silent. The first is determined by the slider `probofreveal` with range (0, 10) and the second one by a probability to which is assigned a random value that vary between 1 and 11 `probofsilence`. If the will to confess is higher than the tendency to remain silent the agent creates a new link with a police station. The latter is reported on the Interface exactly as blue house. Hence the insolvent agent who after having had contacts with the `usurer`, decides to reveal this problem to the police, he will be tied to this other breed `policemen`. The remaining silent condition ($\text{probofsilence} \geq \text{probofreveal}$) offers two possible outcomes to the agent. Dying or spending his money resources entirely to repay the `usurer`. The choice in turn depends on another variable called `liferisk` to which is assigned a random value between 1 and 11 and on a slider in the same range of value denominated `survivingthreshold`. If $\text{liferisk} > \text{survivingthreshold}$, the agent will die, otherwise his color will turn to black. The following image (Fig. 4) reports agents in this condition.

Fig. 4



The hypothesis of dying is related to the risk of incurring in violent actions moved by the usurer, not to starvation or similar reasons. Hence we suppose that a minimum money availability aim to first needs such as foods remains even to the insolvent agents.

2.4 Herding

Another aspect of the model is noteworthy: Herding. We define this as the tendency of an agent to behave exactly as the others around them do. More specifically, a command states that if an agent with determined characteristics is in a distance from the agent set less than 1 (*in-radius*) then he takes the color of the agents around him.

An example of the command related to this action is noticeable below:

```
to imitate
ask persons with [ earnings > 12 and color = brown ]
[ ask persons with [ earnings > 12 and color = brown ] in-
radius 1 [ set color brown ] ]
```

3 Performed Experiments

Experiment 1

Parameters treated:

- `n_of_individuals < 20`
- `nofsons = 4`
- `womentendencybusiness = 1`
- `mentendencybusiness = 1`
- `revenues = 11`

With a very low number of agents in the world, a high number of sons and women and men tendency to business equal to 1 we can notice a series of outcomes. First of all it is guessable, and also noticeable by the label earnings applied on each agent, that the quantity of earnings accumulated by the agents is scarce. A consequence is the very low amount of money in the few positive voices of expenses reported in the monitors. This happens not only because of the few individuals but to the tendency of business of both the kinds of agents, which is low and does not envisage consistent amount of money to be spent. Almost the totality of the destinations of expenditure of agents, whether women or men is very next to 0. Money spent by men in education for children is almost always 0, whereas the level for women changes and it is not always 0. Men spend in health expenses relatively few, what sounds interesting is that the spending for leisure activities of men almost never goes to 0. The opposite happens to the money spent for well-being by women, whose level is zero given the high number of sons. As said before, in a world with few individuals, generally the amount of money spent is extremely low, as reported by the monitors of men and women expenses. Independently from the education constraints everybody seems to

receive microcredit loans in this context . In some cases the proportion of men business activities exceeds the level of women business activities.

By setting the number of sons equal to zero a relevant change is noticeable in the amount of money spent by women for personal well-being, it increases, or at least it results to be very often different from zero. The voices of expenditure that remain constantly zero under this new circumstance are the ones destined to education by men and women and the medical expenses as far as women are concerned. The amount of money spent by men for leisure time activities remains, also in this case, positive.

Experiment 2

Parameters treated:

- `n_of_individuals = 80`
- `nofsons = 4`
- `womentendencybusiness = 1`
- `mentendencybusiness = 1`
- `revenues = 11`

In this experiment the number of agents in the world radically increased. The number of sons remained high and tendency to business of women and men has been set to its minimum level, so as to avoid possible situations of insolvency that would have as a consequence few data for the amount of spending in the economic choices. In this context it is noteworthy the significant amount of expenses undertaken by women in health and education. Hence the “monetary activism” of women here is sensibly higher with respect to

the first experiment. But this is simply due to the increased number of agents, the other conditions are the same as before.

Experiment 3

Parameters treated:

- `n_of_individuals = 80`
- `nofsons = 4`
- `womentendencybusiness = 1`
- `mentendencybusiness = 1`
- `revenues = 20`

By increasing the level of revenues to the maximum the voices of expenses do not change. They are always leisure time and health expenses for men and health and education expenses for women. Hence we deduce that in this context `revenues` do not represent a crucial variable able to change the choice of expenses. What is different is the total amount, that thanks to the higher revenues raised significantly. An example is the monitor reporting the total expenses for men and women that goes from 139.5 under these circumstances to 104 with `revenues = 11`, as in the previous experiment.

- `nofindividuals = 80`
- `nofsons = 0`
- `womentendencybusiness = 1`
- `mentendencybusiness = 1`
- `revenues = 20`

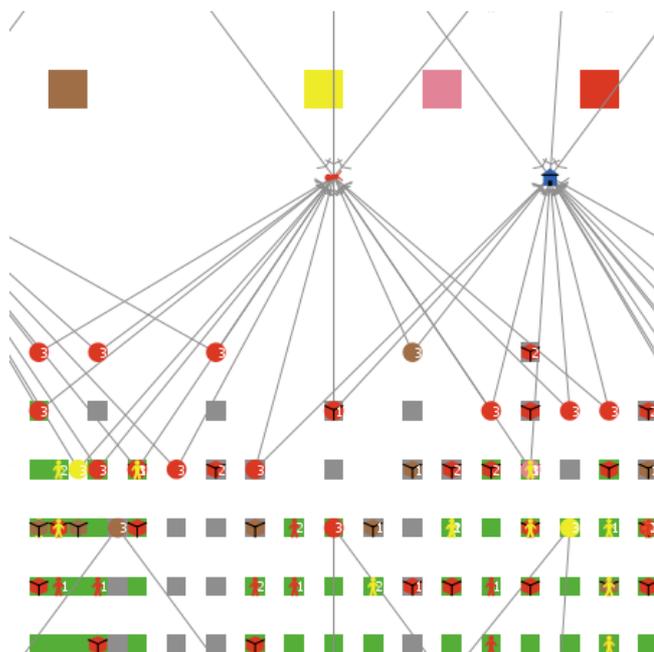
With the only change in the number of sons, setting this variable to zero, we notice a wholly different behavior of agents in terms of their choices of expenditure.

Women well-being expenses increase considerably , together with it the two other voices that do not go to zero are the leisure time and health expenses for men.

Experiment 4

Here all parameters are as before, apart from `revenues` set at a very low level, 4. This change does not alter the positive voices of expenditure and the ones that remain set to zero, but it sensibly decreases their amount. This outcome is not only due to the decrease in money availability of agents but rather because agents went bankruptcy and their remaining available funds, under the condition of surviving on the dangerous relationship with the `usurer`, are aimed to repay the latter. This is highlighted by the link that puts in relation the insolvent agent and the usurer, as already specified above. In such a context of low `revenues` the circle shaped agents symbolizing insolvent individuals are almost anywhere, together with their links.

Fig. 6



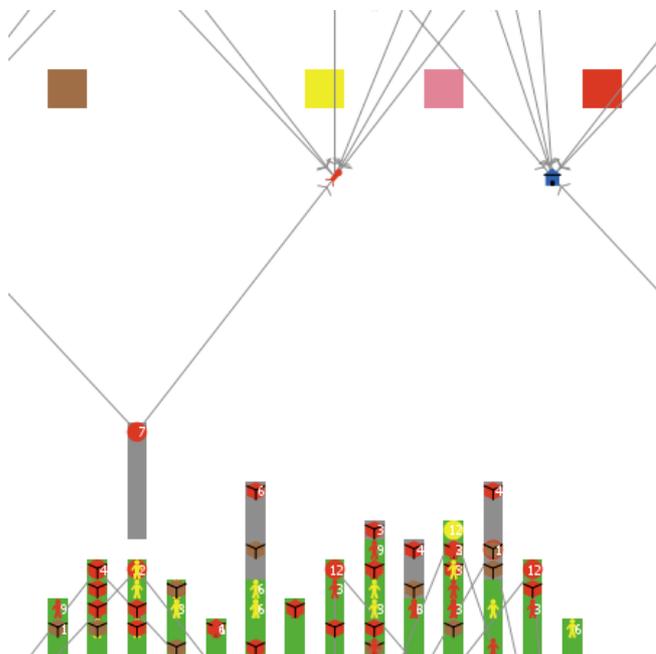
Experiment 5

Parameters treated:

- `instructionBasis = 0`
- `minimumeducation = 20`

An important discriminant in the model, aforementioned, is the level of education of agents. It is not only determined by an upward threshold (`minimumeducation`), but also by a number that establishes from which level onwards the years of education are determined. Years of education is a variable that goes from `instructionBasis` to a random number, that can vary in a range of 20 according to the starting point, the `instructionBasis`. By setting the latter equal to 0 and the minimum level of education at its maximum it is difficult for the agents to get the sufficient level of instruction necessary to be eligible for Microcredit loans. As it is noticeable in the figure below (Fig. 7), those who did not receive the conditional cash transfer are also the ones without the label reporting the earnings, since they did not move at all, i.e. without available funds received there are no resources to start an activity.

Fig. 7



By only changing the number of individuals from a very high population level in the model to a very low data what is clearly noticeable is that only in the case of a low number of people it is possible for men to overcome the level of business activities undertaken by women (Fig. 6), especially under certain conditions that will be specified later in the following experiment. With a high number of people in the world the gap between women and men in business activities is net (Fig. 7).

In a sense this reflects what is one of the real outcome of Bolsa Familia program, hence the fact that women, if entitled with the right instruments (in this case financial ones) are able to outstand in the society, as long as the latter is big and diversified, favoring the arising of their business skills. Even if these lasts can result in merely domestic jobs as sewing or make bread at home and selling it, they show that women do and invest with money they are provided with, instead of men, whose voice of leisure activities in their budget never becomes 0.

Fig. 6

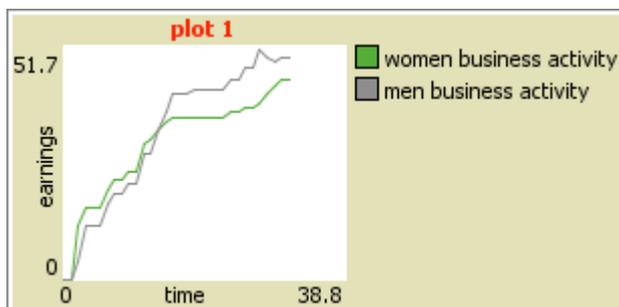
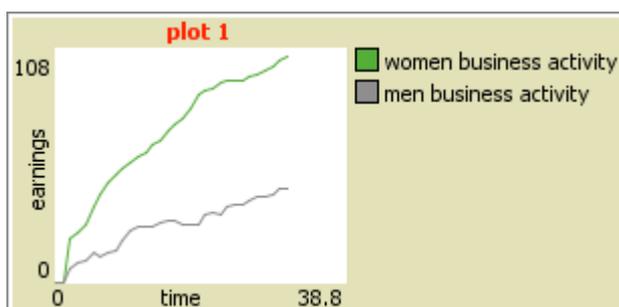


Fig. 7



Experiment 6

Parameters treated:

- `womentendencybusiness = 3`
- `mentendencybusiness = 1`
- `stepsforwardwomen = 1`
- `stepsforwardmen = 3`

In this experiment we will consider an exogenous action such as insolvency, that can result in a modification of choice expenses or in a stop of business activity for those agents who are affected by it. Imagine now to work only with parameters which enter in the modification of earnings (`tendencybusiness`) and in the business activity (`stepsforward`). By altering these values it is easily noticeable that men can reduce the gap with women in terms of business activity, and sometimes even overcome the female agents. In this context women move slowly but they make profitable activities at a higher rate with respect to men. This propensity results in higher earnings as well as in higher expenses that slow the activity of women in the world, by incurring in an insolvency situation.

Looking at Fig. 8 it is straightforward to figure out the condition in which a woman found herself. The female agent is represented in the centre of the figure as a circle shaped individual, with earnings 12. So we guess that the woman earned, over the period of business activity, a higher amount of available funds at a slower rate than men did but with higher intensity. She has shape circle and color black, hence we can deduce that this agent did not reveal her relation with the `usurer` and destined her financial resources to repay her debts to the latter. An adding element to confirm the tendency to indebtedness of women is showed by the reporters of women and men expenses, which always highlights a significant gap between the two values, with female agents sometimes even doubling the

expenses of male agents. However this financial situation does not alter women's economic choices, they destine their income always to the same voices, i.e. health expenses and education per children. In this context we considered a number of children equal to 3, and it resulted in amount of money spent for their personal well-being equal to 0. Definitely, the latter is a further confirm of the determinant role of a numerous family in the amount of money spent for that economic choice.

Of course all the conclusions derived in this experimental context as well as in the others reduce their size as long as we diminish the number of individuals in the world. The gap between the level of expenses sensibly decreases and sometimes the expenses of men even surpass those of women.

By retreating the parameters in the following way with a further component:

- `womentendencybusiness = 1`
- `mentendencybusiness = 3`
- `stepsforwardwomen = 3`
- `stepsforwardmen = 1`
- `nofsons = 0`

Firstly what we notice is a visually fragmented situation. This impression is due to the fact that men have a more restricted possibility of movement in the business world, in accordance to the criteria of Microcredit original project of Bolsa Familia, whose preference to transfer cash towards women rather than men is well-known. Hence in the reproduced world of course men who move are the ones entitled with Microcredit, but we can deduce that their difficulty of moving is due to the lack of confidence still placed in them. In the Code this form of constraint is reported by the command `have-business`, run with command `go` :

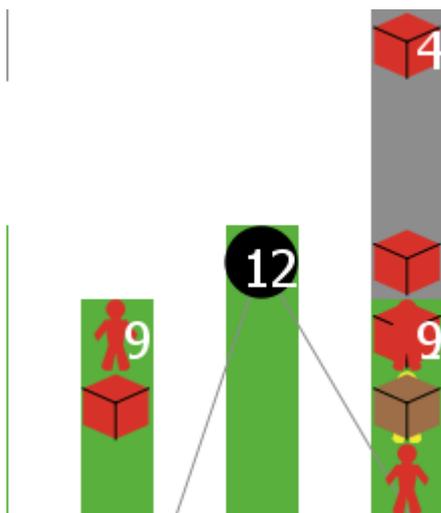
```

to have-business
ask persons with [ shape = "box" ] [
    if pcolor = white [ set pcolor gray

```

Women, despite their worse situation with respect to men, an inferior earning, are able to conquer a position in the business world not so far from the one where men place themselves. A proof of this result is provided by the monitors reporting men and women expenses, that despite the previous situation highlights gap between the two kinds of persons but not very consistent.

Fig. 8



4 Conclusions

The aim of the model here explained has been the one to give a satisfying overview of a Microcredit project implemented not only for the improvement of business activity in the region where it has been applied, but rather to enhance the quality of life of Brazilian citizens, through an increase of investments in education and health activities. Indeed in the

model what is crucial is the way agents spend their money, towards which voice of expenses they aim their funds. The main conclusion that can be driven, in line with the Bolsa Familia program actually implemented and in accordance to the experiments here above undertaken, is the crucial role of family size in the society and the predominance of women. The former has been analyzed several times, we can affirm that the number of sons determines in absolute terms the choice of expenses of women, i.e. having many sons revealed to be a constraint for personal well being expenditures as well as not having completely resets expenses for education. The latter aspect, the predominance of women, is easily guessable by altering the variables reputed to calculate the advantages of economic activity or disadvantages of being engaged in certain financial troubles, despite these lasts women conquer a remarkable position with respect to men. In the model we limited the activity competition between the two types of agents also by including the possibility of insolvency, this condition has been introduced with the aim of representing an external variable that always in a society can alter the pre established course of the events.

To sum up, dominant agents result to be women, if entitled with correct endowments, and the most important variable is the dimension of the family, measured via the number of sons. Hence, theoretically, we are in line with the basic assumption of the Bolsa Familia Program that consider, among the discriminatory aspects, also the family dimension and women as preferred actress in their project.