RESOURCE MANAGEMENT IN COUNTRY DEVELOPMENT

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Indice

1 INTRODUCTION

In this article we want to examine the problem of the correct distribution of resources, inside our economical system. Doing this, we will try to organize a simulation model

using the program NetLogo to simulate the variation of resources in time under different conditions. Changing these conditions, we will see how to minimize the time in which all people arrive to the best possible conditions. Before doing this, it is necessary to introduce the problem, discussing the general situation. For semplicity, we can divide the condition of the countries of the world in four categories:

1. poor with resources;
2. poor without resources;
3. rich with resources;
4. rich without resources.

How can we frame the problem? If the poor population want to develop, they have to ask external help, because they have not enough means, and they can do this in two ways. They can:

1. borrow funds by an internatonal institution;
2. accept investment from a rich country that it will invest. As a consequence the rich country will recive the profit of the poor country.

In the first case the international institution will invest under a certain condition: the poor country must develop a democratic organization, knowing that often poor countries have dictatorial regimes, and for this reason they do not receive international financing. This situation will aggravate the poverty of the country and will bring ignorance to the population, for lack of resources for istruction, and than the dictatorial regime will continue to rule the country, generating a vicious circle: how can the situation be unstacked?

1. informing people of their situation;
2. trying to let understand that with collaboration they can improve their situation and so accede to the funding.

So, we arrive to introdce the problem of decentralization of resources, so that gouvernement can invest them on the territory. If we want to arrive to a satisfactory solution, all these things must be accompained by a correct management of resources by the central gouvernement, that must divide it equally between the local gouvernements. So we can photograph the situation with some points:

1. inequality of the distribution of resources, that we can solve with the action of strong central gouvernement;
2. situation of war that brings to week gouvernements and aggravates point 1;
3. uncorrect taxation, that brings to an inequality of distribution of resources, that brings situation of civil war and than we return to point 2.

We can observe that a correct taxation can improve the social inequality, and than bring peace to the state. We observe also some points:

1. we can link the situations of war, so political situation, with the economical situation of poverty;
2. from a demographic point of wiew, we can say that poverty brings a greater growth of population, and so a less availability of resources that goes to increase the poverty, creating a vicious circle.

From this point of wiew another relevant fact is the growth of population that we can demonstrate being exponential (proportionally to the quantity that is alredy present). Another important problem to analyze is how can i measure the level of income of the population. From this point of wiew, it is interesting to know that in 2017 the 1 percent of the richest population of the world, had the 47,2 percent of the total wealth of the world. This information underlines the importance of the problem for the future, and how the inequalities can bring to critical situations. Returning to our question, an important indicator of the revenues of the population is the industrial capital that we can divide in four parts:

1. resources output: production of raw material;
2. agricoltural output: means for agricoltural;
3. services output: schools,banks,hospitals...;
4. industrial investments: means of industrial production.

The measure of productive capital can be a good extimator of the richness of a country.

2 SIMULATION

Now we can start talking about the central part of the work, consisting on the simulation. Trying to describe our problem in Netlogo, a software for agent-based simulation, I structured the program in an initial part, followed by four function:

1. defining variables and breeds;
2. function "to clean";
3. funcion "to create-world";
4. function "to create";
5. function "to invest".

The purpose of the simulation is composed by four parts:

1. creating a world that reproduce the general situation of the distribution of resources, simulating people of different countries divided in 4 categories of richness;
2. evolving the situation;
3. plotting the richness of total agents, changing in time.
4. making four histograms of the number of agents of single categories of richness, for each of the four part of the world.

We now will describe how in general the simulation will work.

2.1 Functioning of simulation

We will create a world divided in four parts that will represent the four categories of country with different richnesses that we have decided to analyze. Each agent of the simulation has three variables turtles-own:

1. age;
2. richness;
3. position on the world.

Obviously, in the part of the poor world will be more probably finding agents with less richness, and so on. We will also can decide the number of agents for each part of the world. Given the initial situation of the world we will start the function "to go" (with the option "forever"), and we will see how the world will develop.

2.2 Defining variables and breeds

Now, we can open the code of the simulation, and we can start reading it. The first thing we can observe is the part of the program of declaration of variables:

1. TURTLES-OWN VARIABLES
    - "age", indicating the age of the agents;
    - "richness", that can assume the values 1, 2, 3, 4 indicating the four categories;
    - "NE, NW, ES, SW", indicating the position of the agent on the world.
2. GLOBAL VARIABLES
    - "invested", indicating if an agent of a rich country invested;
    - "investito", indicating if an agent of a poor country invested. They assume the value 1 if the investment has been made, and 0 if not.
3. PATCHES-OWN VARIABLES
    - "nordest, nordovest, sudest, sudovest", indicating positions of patches on the world;
    - "EW", a multiplyer for probability of development of a country, due to the availability of energy resources, different for each of the four parts of the world.
4. BREEDS
    - "person", the turtles assume this type of form.

2.3 studying the different functions

After we have defined the general structure of the program, we can start talking about the functioning and the logic of the different functions that make up our program.The program is composed by two main function "to setup" and "to go", in wich we have defined four subfunction, only the last of which belongs to the function "to go". So now, we will analyze each of them.

2.3.1 function "to clean"

It has the only purpose of cleaning the world interface after a simulation. We can use this command to restart all, after a test.

2.3.2 function "to create-world"

With this function we can divide the world of Netlogo in four parts, each of which corrisponds to one category in which we divided the types of richness of the people. Using the condition command "if" we consider all possible values of the coordinates x and y of the turtles, that in Netlogo are "pxcor" and "pycor" (they are relative to patches). Now we can color the patches of each part of the world with different colors to differentiate the parts of the world, using the command "set pcolor" followed by the number of the color. With the patches-own variables "nordest", "nordovest", "sudest", "sudovest" we named the patches in different ways. In this section we also initialize the patches-own variable "EW" that we have described starting this subsection.

2.3.3 function "to create"

We define with four sliders, the variables N, M, P, Q, for creating a different number of turtles in each part of the world with the command create-turtles. With the function "set xcor random max-pxcor" and "set ycor random max-pycor" we can define in which clock face of the world we are: for example if I want to position the turtles in the part of the world with $x < 0$ and $y < 0$ i will use the command "set xcor random min-pxcor - 1" and "set ycor random min-pycor - 1", because the world of Netlogo goes by 0 to 16 and by 0 to -16 for the coordinates, but I do not want any turles on the point (0,0) so I add 1 to positive coordinates ("set xcor random max-pxcor + 1") and I decrease by 1 the negative coordinate("set xcor random min-pxcor - 1"). In this section we also set the shape of the turtles like "person" and we toss up two numbers for to define the probabilities of the agents to have a certain age and richness. It will be more probably for poor agents being younger, and for rich agents being older. Modifying the range in which I want to be the number extracted, I modify the probability: infact, if for example the number can be extracted in a range between zero and 0.80, it is more probably than a number that can be extracted between 0 and 0.50 (number can assume all float values between 0 and 1). In this function we also set the turtles-own variables NE, NW, ES, SW, for the position of the turtles. Note that I setup different colors for agent changing with theyr richness for recognyzing them. With the command "set color" I set the color of agents:

- "black" for very poor agents;
- "pink" for rich agents;
- "violet" for poor agents;
- "orange" for very rich agents.

If during the simulation the richnes of the agents will change, the agents will change the color. We can note that the ranges of richness go by 1 to 4, and i have a certain probability of being in each range.

2.3.4 function "to invest"

This function will describe the interation inside our program, and it is composed by some different sections:

1. CONDITION OF END SIMULATION: with the command"if all? turtles [color = 25] [stop]" I said the program to stop when all turtles of the world are very rich (richness = 4) and they assume the orange color.

2. CASE 1: AGENT OF RICH COUNTRY INVESTS With the command " let investitor-ricco one-of other turtles with [SW = 1 or NW = 1]" I choice an agent of one of the part of the rich world and, if the choice is successful, I ask to the agent that I named "investitor-rich" to invest. Then I draw lots two numbers:

   (a) one for the probability of the rich agent to invest;

   (b) one for the probability to develop after his investment.

   Note that I multiply the probability of investment for a constant named "EW", that indicates the limitation on the operation due to the availability of energy of the country. If the investment has been made, I set the variable "invested = 1" and I draw lots another number to define the probability of the rich agent that invests to develop and so to add 1 to his degree of richness for all categories. Now I must analize how the poor agent on which the rich agent invest, changes: doing this i named "helped1" an agent of one of the poor part of the world and, if the variable "invested" is equal to one (saying that the investment has been done), I draw lots a number to define the probability of the agent of the poor country to develope and so i say to him to change his richness of one category depending on wich category of richness he has.

3. CASE 2: AGENT OF POOR COUNTRY THAT INVEST LOCALLY WITH RESOURCES OF THE RICH COUNTRY With the command " let investitor-povero-helped one-of other turtles with [NE = 1 or ES = 1]" I choice casually an agent of the poor country and, if the choice has been made correctly, I draw lots two numbers:

   (a) one for the probability of the poor agent to invest;

   (b) one for the probability of the poor agent that invest to develop.

   So I define the probability with a slider and the same energy costant that I used before and, if the investment has been made and the program comes into the "if", I set "investito = 1". Than I set another constant with the slider to define the probability of development of the poor agent and, coming into this "if", I define the probability of development of the poor agent that invests to develop, saying to him to advance his degree of richness by 1 for all categories (to the start ipotetically, he can have all degrees of richness).

4. CASE 3: AGENT OF THE POOR COUNTRY THAT INVESTS LOCALLY WITH HIS RESOURCES With the command " let investitor-povero-self one-of other turtles with [NE = 1 or ES = 1]" I choice casually an agent of the poor part of the world (with or without resources), and than I draw lots three numbers:

(a) one for the probability of the poor country to invest;

(b) one for the probability of the poor agent that invests to grow up his richness;

(c) one for the probability of development of the agent on which the poor agent invested.

How does the poor world change?

(a) The first phase is to define how the investitor changes: the poor agent can invest only if he is rich or very rich, considering that if he is very rich is more probably his investment. If the investment has been made I set the variable "investito = 1".

(b) the second phase is to define how it changes the poor agent on which the investitor acted: if the variable "investito" is equal to one, it means that the investment has been done and so I can name "beneficiario" a random agent between the others of the poor world. At this point I can draw lots a number to define the probability of development of this agent and so i can ask to him to advance his degree of richness if the investment has been made and if he developed.

Note some points:

- the probability of development of the poor agent is bigger if the investitor is poor than the investitor is rich;
- the variables "investito" and "invested" serve to say the program that the investment has been done and the agent on which I want to act has been chosen.

2.3.5 notes about variables for probabilities

In all our function we worked with probabilities, drawing lots some numbers. In this section we will summarise theyr utilities.

1. FUNCTION "TO CREATE"
   - number1, for probability of age for poor with resources;
   - number5, for probability of richness for poor with resources;
   - number2, for probability of age for poor without resources;
   - number6, for probability of richness for poor without resources;
   - number3, for probability of age for rich with resources;
   - number7, for probability of richness for rich with resources;
   - number4, for probability of age for rich with resources;
   - number8, for probability of richness for rich with resources.
2. FUNCTION "TO INVEST"
   (a) RICH COUNTRY WILL INVEST ON POOR COUNTRY WITH HIS RESOURCES

- number9, for probability of the rich country to invest on poor country;
- number10, for probability of the rich agent to develop after the investment on poor country(develop is equal to advance the richness of the agent of one category).

(b) THE AGENT OF THE POOR COUNTRY INVEST LOCALLY WITH RESOURCES OF THE RICH COUNTRY

- number12, for probability that the poor agent will invest locally;
- nuber13, for probability of the poor agent that invest will develop.

(c) THE AGENT OF THE POOR COUNTRY WILL INVEST LOCALLY WITH HIS RESOURCES AFTER HE WILL BECOME RICH OR VERY RICH

- number14, for probability of the agent of the poor country to invest locally with his resources;
- number15, for probability of the the agent of the poor country that invest to develop;
- number16, for probability of development of the poor agent on wich the poor investitor acted.

3 PURPOSE OF THE SIMULATION

What is the purpose of our simulation? working with the sliders of probability we can see how it modifies the time of the simulation and what is it the best condition of probability in which all agents become very rich in as soon as possible. So I want to underline the link between time of simulation and probability of development and investment. I advise that doing the simulation could be some differences between its results and what we expect: this problem can be explained saying that the time in Netlogo is discretized in ticks and not continous like the real world and so, in short time of simulation, the differences could be relevant.

4 RESULTS,GRAPHICS AND COMMENTS

4.1 generality

After this introduction on the structure of the simulation we can start it and analyze the results. For starting the simulation we must to act the botton "setup", for to create the world, and then the botton "go" to start the simulation. The button "go" can be set on "forever" for not stopping the development of simulation. Now we will report the histograms of the number of agents of each type for the four part of the world in three moments:

1. initially;
2. at a certain tick;
3. at the end.

Infact with the command "histogram" I can plot the number of agents of each type in the four parts of the world (four graphics) and with the command "plot" I plotted how the number of turtles of each type in all the world, changes in time. Obviously the result must be the fact that the number of "very rich" will grow with the time of simulation and, modifying the probabilities with the slider, it will change faster or slower. The color of the agents is usefull for the program to recognize the richness of the agents and then plotting the number both in the plot and in the histogram.

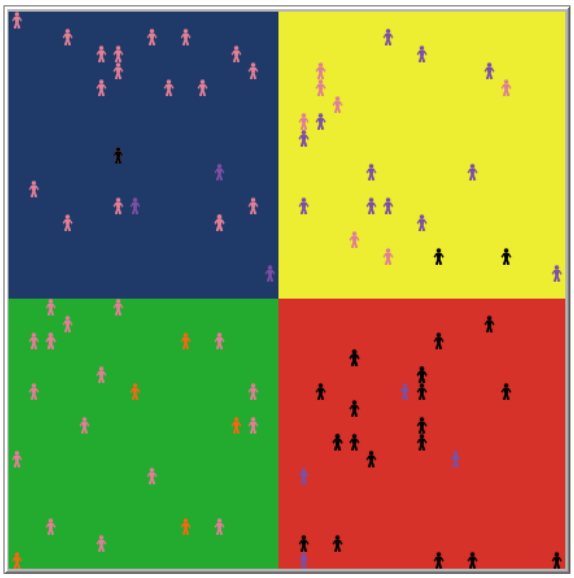
4.2 starting situation

4.2.1 description

Pressing the button "setup", for starting the simulation we arrive to have this situation, plotting the number of agents of four type of richness in all parts of the world: we see, as we want, that richest people is in the two rich parts of the world, according with probability, and similarly, in the two poor parts of the world we have more poor and very poor agents.

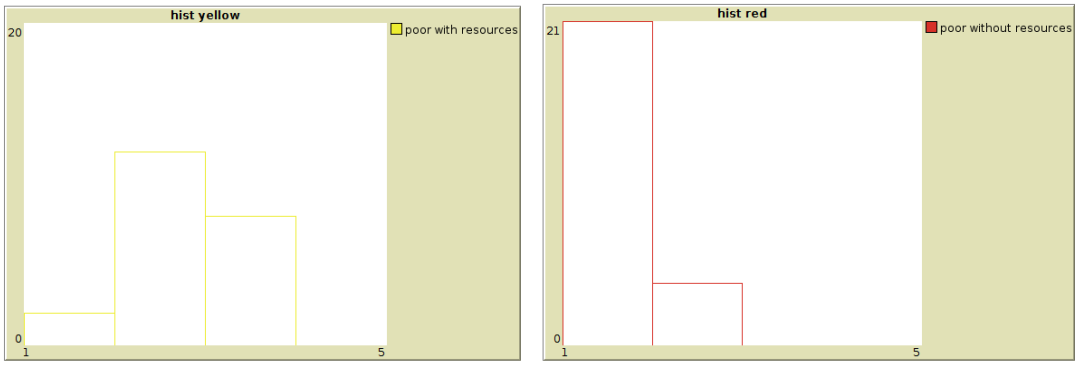
4.2.2 graphics

Graphic of the world:



graphic of initial world

Now the plot of the richness in all four parts of the world:



graphic of poor world

graphic of rich world

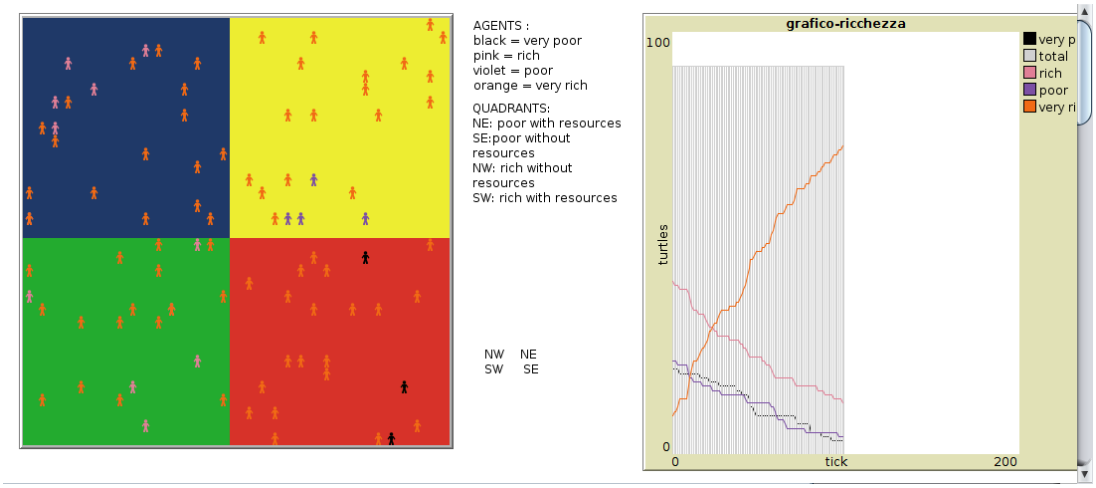
4.3 after some ticks

4.3.1 description

Now we take the situation after 207 ticks seeng how it evolved: we can observe that the number of rich and very rich people increased, according with probability of development: for this reason, changing the probability of investment and development of the agents with the slider we can see how does the time in wich the system arrives to the final configuration change, and we will discover that, increasing the probability of investment of poor and rich country, the time in wich the system will arrive on the final configuration, will decrease.

4.3.2 graphics

Graphic of the world:



graphic of the world

Now the plot of the richness in all four parts of the world:

richness of poor world

richness of rich world

4.4 end of simulation

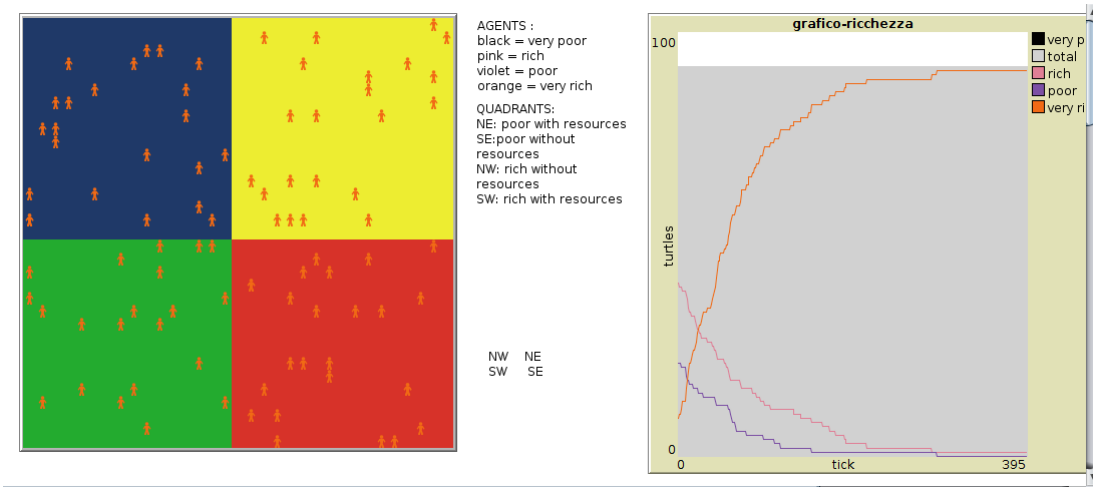
4.4.1 description

Obviously in the final configuration all the agents are very rich: the point is seeing the number of ticks in wich the system arrives to the equilibrium configuration. In our case, the program ends in 1573 ticks, but varying the parametres the situation will change. First we fix the parameters B = 0.80, C = 0.20, F = 0.50, H= 0.90, L = 0.90. Infact they describe the probability of development that is bigger if the poor country invests with his resources and smaller if he invests with the wealth of rich country. Obviously for the rich agent that invests the probability of development is high, but not for the poor agent on which he invested. Now we will change the parametres A, D, G, I, that define the probability of investment of the single country seeing how the time of simulation changes:

- setting A = 1, D = 0.85,G = 0.10 , I=0.20, the time of end simulation is 316 ticks;
- setting A = 0.10, D = 0.50 G = 0.90 I = 1.00, the time of end simulation is 2159 ticks;

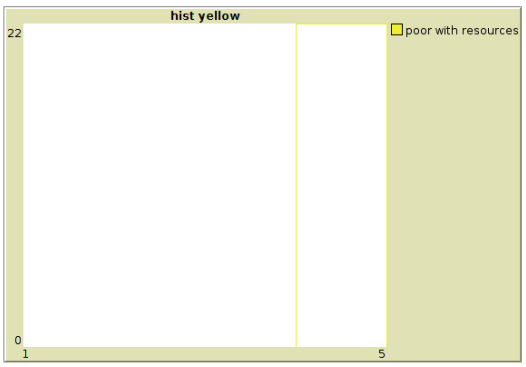
4.4.2 graphics

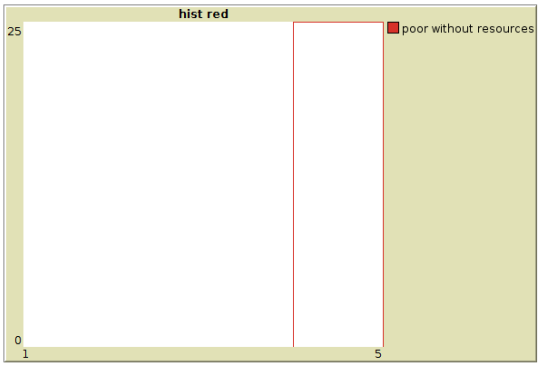
Graphic of the world:



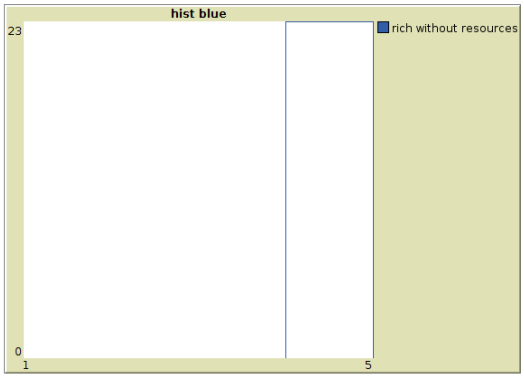
graphic of the world

Now the plot of the richness in all four parts of the world:





richness of poor world



richness of rich world

5 CONCLUSIONS

With this model we can describe the general situation of the distribution of wealth among the population. Changing the parametres of the probability of investment and development, we can analyze the time in which all people becomes very rich to arrive to a configuration that minimizes it. This model can be complicated considering also other parametres for the development as:

- the degree of democracy, fondamental condition to arrive to the funding for poor countries;
- the level of instruction of the poor country, useful to reach the democracy;
- differentiate agents between woman and man, to change the level of richness (analyzing also the differences between salaries of man and woman that today unfortunatly are very different) and age;
- the introduction of the figure of an international istitution that helps the poor countries that arrived to a good level of democracy (so linked with instruction and democracy).

In this way we can predict situations and so chosing the best way to handle the resources and, with other more developed programs of agent based simulation, we can consider different type of resources and, with a study of their disponibility, chosing the type and the way to exploit them, that gives us the bigger time of exploitation.