Wealth Distribution and Social Mobility

Ananya Bajaj
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Abstract

Income and its distribution have always been a central problem for many growing economies. Unequal distribution of income creates a divide between different sections of society, which is a cause of concern since it can hamper the growth of the economy. This wealth distribution and associated social mobility are studied by building upon the Wealth Distribution Agent-Based Model adapted from Epstein and Axtell's Sugarscape simulation, using agent-based modeling. The modified ABM mimics a real-life economy, with features like a progressive taxation system and wealth inheritance by the offspring. The implemented measures are then modulated in order to achieve wealth equality, to the best extent possible.

Introduction

Economic inequality refers to the unequal distribution of wealth and subsequent opportunities among different groups of society. It is a pervasive phenomenon seen in almost every country in the world, where people are pushed into poverty with little chance to climb the social ladder. This agent-based model aims to simulate an artificial society, to evaluate the various factors that affect the distribution and circulation of wealth in an economy. The results are presented in terms of a Lorenz curve and the Gini Coefficient.

The original model is not an accurate representation of a real economy. It fails to take into consideration several factors economic factors and sidelines the role of agents like the government. In order to mimic the modern-day economy, certain extensions have been added to the existing model. First, a progressive income tax system has been put in place. Second, the amount of wealth in the economy has been varied and lastly, wealth inheritance by the offspring has been introduced in order to account for the intergenerational mobility of assets.

The modified ABM is an attempt at mirroring a modern-day economy. The model offers insight into the different measures that can be taken to improve wealth distribution. It also studies if the implemented measures can help to reduce wealth inequality and if so, then to what extent can it improve the same.

Method: Model design and structure

1. **Original Model**

In this ABM, an artificial society has been created with two main entities - the available wealth, represented by the patches, and the people represented by the turtles.

Every patch has a fixed amount of grain/wealth, depending on its capacity. The turtles have different state variables to represent their age, wealth, life expectancy, metabolism, and vision. Metabolism refers to the amount of grain the turtle can eat in every time step and vision refers to the number of patches ahead till which the turtle can see. The turtles are colored differently depending on their initial wealth. Red turtles have less than one-third of the maximum wealth possessed by any person in the economy. Green turtles have wealth lying between one-third to two-thirds of the maximum wealth and the remaining turtles are colored blue.

The model begins with a roughly equal wealth distribution. The people move around the region, in the direction where most of the grain lies, collecting grain that amounts to their wealth. Each individual also has a fixed lifespan. So, once their lifespan runs out or they run out of grain, they die and produce a single offspring with a random life expectancy and a random amount of grain.

The original model has the following actions that are executed in every time step.

1. turn-towards-grain: a turtle procedure, to determine the direction which is most profitable for each turtle in the surrounding patches within the turtle's vision.
2. grow-grain: a patch procedure, to keep replenishing the grain present on the patches, in every grain-growth-interval clock ticks and to recolor the patches accordingly.
3. move-eat-age-die: a turtle procedure, wherein the turtle moves to a patch, costumes grain equivalent to its metabolism, updates its wealth (wealth = wealth - metabolism) and grows older by one unit. This procedure also checks for death conditions.
4. update-lorenz-and-gini: this procedure recomputes the value of the Gini Index and plots the Lorenz Curve.

2. Analysing the Model

The results of the model are studied with the help of a Lorenz curve and the Gini Coefficient. The model's results were in accordance with Pareto's 80/20 rule wherein the minority upper-class population controlled the majority of the wealth in the economy.

However, this model is a very basic rendering of an economy. In order to make the model more realistic and to answer the research questions, the following extensions were added.

3. Extensions in the Model

Progressive Taxation System

A progressive taxation system is one wherein the tax rate varies with the taxable amount. One of the biggest advantages of this measure is that it fairly distributes tax amounts to individuals

depending on their wealth. The upper class is charged 30%, the middle class is charged 15% and the lower class is charged 5% of their total wealth.

Seasonal Availability of Grains

In every economy, the amount of wealth in circulation keeps varying either due to internal transactions or external factors like trade. In order to account for this, three seasons, namely monsoon, spring, and summer, were introduced in the model. During every season, the maximum grain a patch can grow is changed. Monsoons tend to be the most devastating season for crop growth and the maximum grain limit is set to 20 units per patch. During the summer, it is set to 45 units per patch. Spring, being the most ideal season for crop growth has a limit of 80 units per patch. The different limits lead to a change in the amount of wealth in circulation in the economy

Wealth Inheritance by Offspring

In the original model when a turtle dies it is replaced by another turtle that has a random amount of grain. With our modification, when a turtle dies it transfers its wealth to the turtle that replaces it. In this way, the wealth accumulated by the turtles will not be eliminated and will continue among the population generation after generation.

Therefore, every turtle upon its death leaves behind their wealth for their respective offspring. An inheritance tax is levied on this legacy, depending on the initial wealth of the turtle.

The model was run several times with the proposed measures, in order to analyze their effects on wealth distribution and the results were noted.

Results and discussion

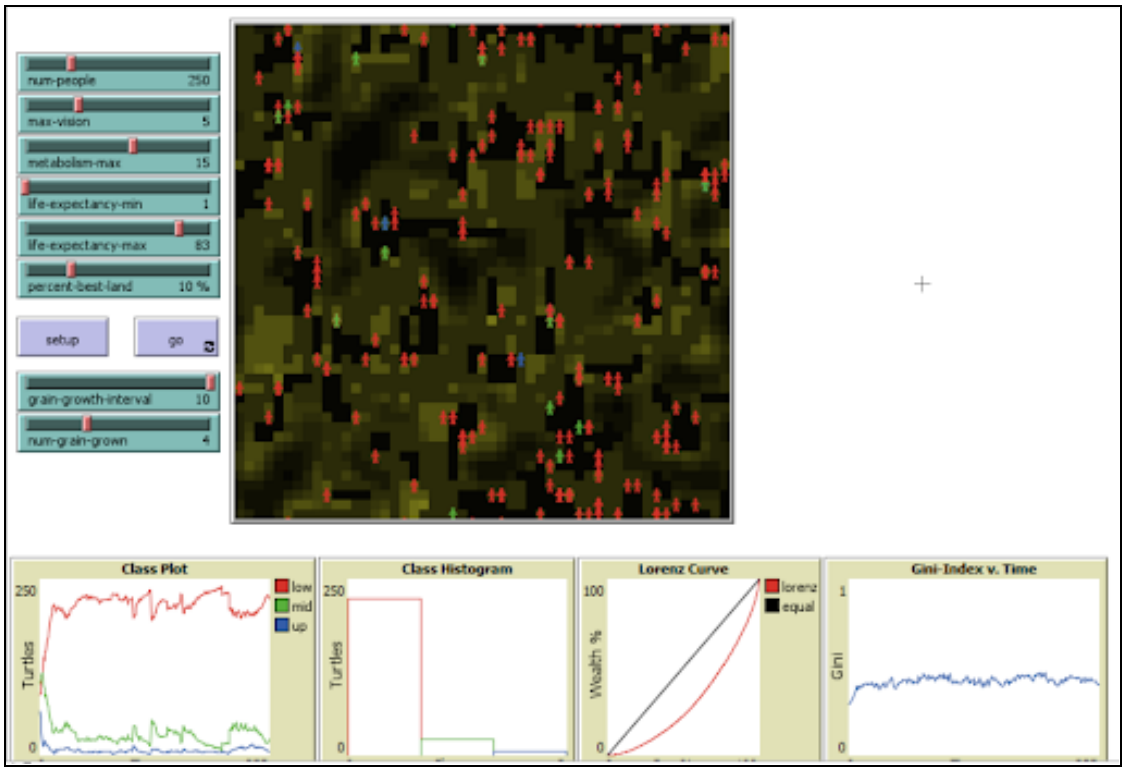
The results obtained in the different cases are as follows -

1. **Initial Observations**

Varying the existing values of the parameters does not affect the Gini Index significantly.

Gini Index lies between 0.32 - 0.38, with an occasional sway to late 0.2s.

Economies grow with time, but in the original model, the wealth remains constant.



Running the original model without any extensions

2. Progressive Taxation System

TAXATION SYSTEM	GINI COEFFICIENT
Absent	0.42232
Present	0.34023

Results obtained after introducing a progressive taxation system in the economy

With the introduction of income tax, there is a considerable change in the Gini coefficient. This is because the income tax leads to a reduction in the wealth held by an individual thereby equalizing the wealth distribution to a certain extent.

3. Seasonal Availability of Grains

SEASON	GINI COEFFICIENT
Monsoon	0.34898
Summer	0.3508

Spring	0.37114

Results obtained by introducing seasons to vary grain (wealth) availability

This extension did not change the Gini Index significantly, thereby implying that the amount of wealth in circulation in an economy does not affect its distribution. Irrespective of the total wealth present, the rich always tend to whole a greater portion of it. So, the wealth inequality remains more or less constant.

4. Wealth Inheritance by Offspring

This is the only extension wherein there was a substantial increase in the Gini coefficient. Inheritance of wealth from the parent generation gives the offspring an unfair advantage as compared to the individuals belonging to the middle class and the lower class. Over generations, this headstart given to them leads to greater wealth inequality in the economy.

This is also the first extension wherein the total wealth in the economy kept increasing before stabilizing to a fixed value.

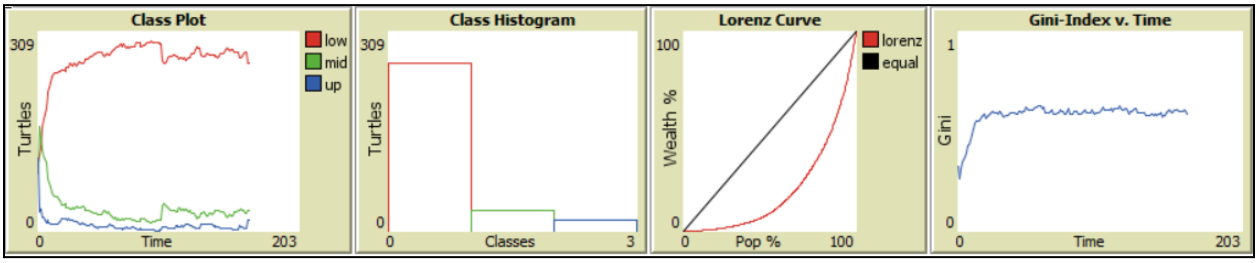
The Gini coefficient lies between 0.6 and 0.7

5. Achieving Wealth Equality

A combination of all the extensions was implemented in order to simulate a real-life economy and to see their effects on the distribution of wealth.

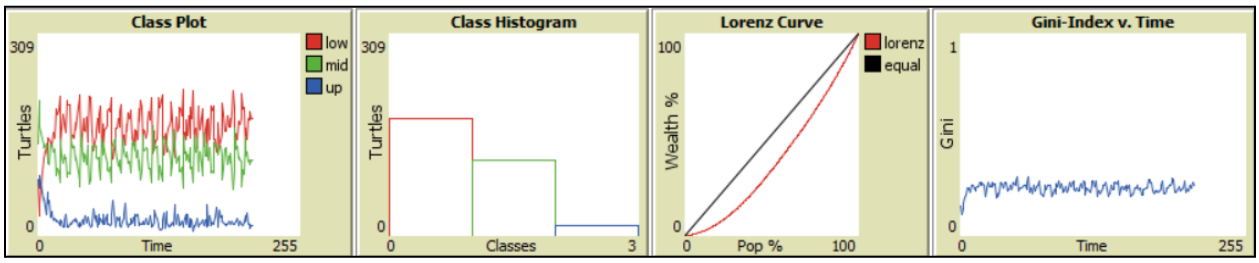
Initially, all the basic parameters like vision, metabolism, life expectancy etc. were kept at their default values (50% of the maximum), the inheritance system was in place and an income tax (30% on the upper class, 15% on the middle class and 5% on the lower class) was levied.

The results were as follows -



Gini coefficient = 0.58755

Upon adjusting the parameter values to their upper limit, removing the inheritance system and levying a disproportionate income tax (50% on the upper class, 30% on the middle class, and nothing for the lower class), a significant reduction in the Gini coefficient was obtained.



Gini coefficient = 0.24929

A Gini coefficient of less than 0.2 represents perfect wealth equality.

Summary and conclusion

The extended ABM successfully mirrors a modern-day economy. The proposed extensions help to analyze the different measures that could be responsible for bringing about a change in wealth distribution.

Using the model, several crucial observations have been made. The amount of wealth present in the economy does not alter the wealth distribution; the inequality still persists. A progressive taxation system helps to reduce wealth inequality. The model also demonstrates the danger posed to society due to the implementation of the inheritance system, even though the total wealth in the economy increases.

It can be concluded that using the following extensions, even though the overall wealth distribution can be improved significantly it is still not possible to achieve a state of complete wealth equality. This highlights the need to study the code more deeply and to implement more features to incorporate the complexities associated with any functional economic system.

The model can be enhanced further by focusing on the existing parameters and adding conditions to them. The metabolism of the turtles can be varied depending on their social class. This will take into account the impact consumption habits can have on wealth accumulation. Furthermore, the vision parameter can also be varied depending on the social classes. The upper class could have a greater vision because of their greater access to money and required resources. The inheritance tax can be modified further by either increasing or decreasing the tax rates over the generations, instead of letting it be randomized. All these changes will improve the model and lead to more conclusive results.

Reference

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