Replication: The Distribution of Wealth in the Presence of Altruism for Simple Economic Models

M. Rodrigues-Achach and R. Huerta-Quintanilla

Keegan Skeate

Economics 6257

Computational Economics

Belk College of Business

The University of North Carolina at Charlotte

May 2015

1. Introduction

Examples of altruism in the economy are common; members of families share with each other, people lend aid to their neighbors and community and it is recognized as a good dead to donate income for the wellbeing of others. In the United States, charitable giving has tripled in the past 40 years and more than $300 billion of donations are made annually. Despite the increase in giving, the Gini Project estimates that income inequality has risen sharply in the United States over the same period. With an increase in philanthropy, intuition suggests that the resulting distribution of wealth would be more equitable, but that may not necessarily be the case. It is not clear if giving by altruistic agents will change the distribution of wealth.

William Damon, author of *Taking Philanthropy Seriously*, notes that “careless gifts can leave recipients in worse shape than before the gifts were made.” It is possible that charitable contributions are unwisely spent. Inefficiencies can arise if philanthropic gifts are “bestowed haphazardly, without forethought or without regard for their effects (Damon 4).” It is worth pointing out that actions often have unintended consequences. Undoubtedly there exists a relationship between philanthropy and equality; however, poor planning and misuse of resources can lead to inefficiencies.

Rodriguez-Achach and Huerta-Quintanilla propose two simple asset exchange models which allow for altruistic behavior in the agents. Computational methods are applied in the two simple economic models in order to research the effect of altruism on the distribution of wealth. Theoretical and empirical results have been varied and inconclusive on the welfare implications of charitable giving, in which case computational methods may add qualitative insights.

2. Economic models

The method applied is a cross-disciplinary approach adopted from the economics and physics literature. Statistical mechanisms and Monte Carlo simulations are used to research the qualitative characteristics of the distribution of wealth in two asset exchange models. The two models represent an economy in its simplest form.

2.1 The Theft and Fraud and Yard Sale asset exchange models

The Yard Sale and Theft and Fraud models are simply an exchange of wealth between pairs of agents in successive periods. There is a decision rule to determine the outcome for each trade, which is the definitive aspect of each of the two models. In the Yard Sale model, the winner takes a random fraction of the poorer player's wealth. In the Theft and Fraud model, the winner takes a random fraction of the loser's wealth. The models can be thought of as gambling markets, or opportunities for arbitrage as the economy oscillates above and below equilibrium.

2.2 Computational Methods

A Monte Carlo simulation is implemented to research the dynamics of the two models, with and without altruistic behavior. As the primary motive is to measure the resulting changes in the distribution of wealth, the evolution of a Gini index coefficient is examined. The trading process is repeated for a given number of Monte Carlo steps and the Gini coefficient reports the distribution of wealth at each step. The distribution of wealth is tracked as it evolves over the simulation, and the final distribution of wealth is compared for varying percents and rates of altruists and altruism. The resulting average Gini coefficients for each specification are then reported. The purpose is to test if the Gini index is significantly lower in the presence of altruism, which would indicate a more equitable distribution of wealth.

3. Methodology

The asset exchange models were written in the Python language. In both the Yard Sale and Theft and Fraud models, there are a set number of economic agents *N* with identical initial values of wealth *m*. Wealth is neither produced nor consumed, there are no savings and the total wealth of the community remains constant. For each Monte Carlo step *MCS*, there are *N* pairs of traders that are randomly selected and a winner is randomly chosen to take an amount T from the loser. Altruism is introduced by defining a certain percent *p* of the agents as altruists. During the trade, if an agent wins and is an altruist, then they will donate a fraction of their winnings plus half of the difference between their wealth at rate *r*.

$$w_i(t+1) = w_i(t) + T - r(\Delta + T) \qquad w_j(t+1) = w_j(t) - T + r(\Delta + T)$$

The amount traded is a fraction of the poorer player's wealth in the Yard Sale model and a fraction of the loser's wealth in the Theft and Fraud model. The fraction of wealth traded is uniformly distributed between 0 and 1.

$$\mathrm{T} = \alpha\mathrm{MIN}(\mathrm{w_i(t)}, \mathrm{w_j(t)}) \qquad \mathrm{T} = \alpha\mathrm{w_j(t)}$$

With the addition of bargaining efficiency, the poorer player has increased odds of winning. The decision rule is a Fermi function which allows the poorer agent to gain an advantage as a function of their relative wealth, and otherwise determines a winner randomly.

$$p(i|i,j) = \frac{1}{1 + \exp\left(\beta\left[\frac{x_i}{x_j} - 1\right]\right)}$$

The research question is whether the presence of altruism will reduce the Gini coefficient in the given economic models.

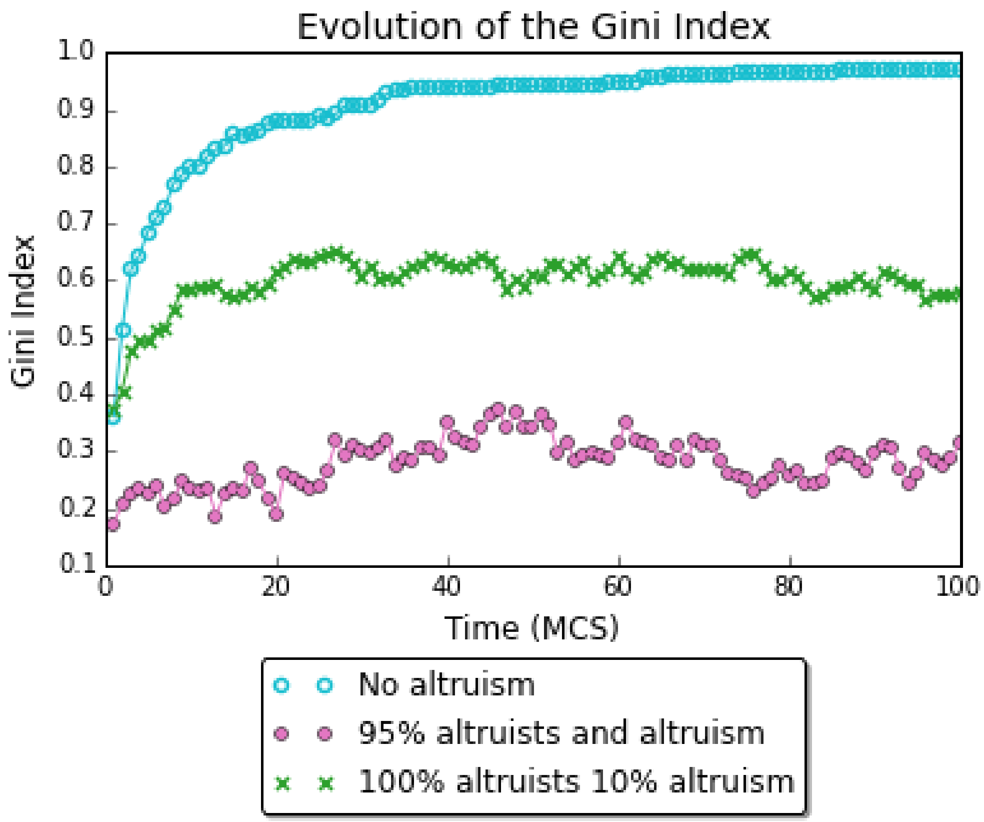
$$G = \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} |x_i - x_j|}{2N^2\mu}$$

Each model consists of 100 Monte Carlo steps and is simulated over 10 realizations with varying percents of altruists, rates of altruism and bargaining efficiency parameters.

4. Results

Figure 1.

The Yard Sale model

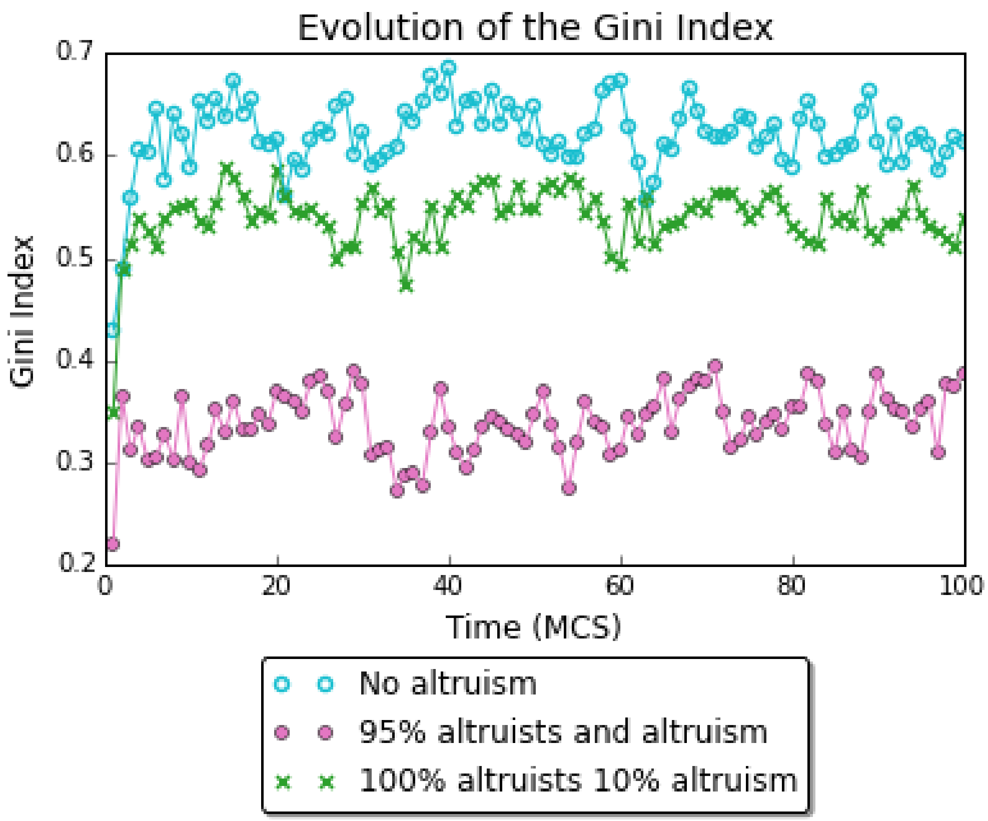


4.1. The Yard Sale model

In the Yard Sale model, it is well known that condensation occurs and all the wealth will be distributed to a single individual. The authors find that condensation still takes place in the Yard Sale model, however the process takes significantly longer in the presence of altruism. I found that the presence of altruism greatly slowed the convergence of the Yard Sale model to condensation. If the number of Monte Carlo steps were increased to 1000, then condensation would likely occur. Altruism affects the Yard Sale model towards a more equitable distribution. The introduction of bargaining efficiency prevents the Yard Sale model from condensation, and results in a Gini index which can be lower than in the Theft and Fraud model.

Figure 2.

The Theft and Fraud model



4.2. The Theft and Fraud model

In the Theft and Fraud model, I found that higher values of *p* and *r* resulted in lower values of the Gini index, which indicates a more equitable distribution of wealth. Furthermore, bargaining efficiency reduces wealth inequality in both models, but not necessarily if values of *p* and *r* are high. The intuition is that if the poorer players have a high probability of winning and there are altruistic agents, the distribution of wealth can become uneven because the odds of winning are biased towards the slightly poorer agents. This is a caveat that was noted by the authors, and shows how inefficient giving can occur even in simple economic models. However, overall the higher percent of altruists and degree of altruism drastically decreased inequality.

4. Conclusion

The main finding is that with the introduction of altruism in two simple economic models, the distribution of wealth becomes more equitable. There is a positive relationship between the percent and rate of altruists and altruism and wealth equality. The qualitative result has considerable implications, considering that income inequality is an externality that is shared by all. An increase in equality is arguably welfare improving. The computational models suggest that many slightly altruistic agents increase equality in an economic system. The results suggest that society will be better off if everyone displays at least a small degree of altruism.

References

Damon, W. (2006). *Taking philanthropy seriously: Beyond noble intentions to responsible giving.*

Rodriguez-Achach, M., & Huerta-Quintanilla, R. (2008). The distribution of wealth in the presence of altruism for simple economic models.

Appendix

Figure 2. Gini Index in the TF model

p \ r	0.0	0.2	0.4	0.6	0.8	1.0
0.0	0.62	0.65	0.64	0.64	0.62	0.64
0.2	0.62	0.62	0.57	0.60	0.60	0.58
0.4	0.62	0.57	0.55	0.56	0.54	0.55
0.6	0.61	0.57	0.51	0.50	0.48	0.48
0.8	0.62	0.54	0.46	0.43	0.40	0.38
1.0	0.63	0.49	0.41	0.34	0.30	0.32
B =	0	0	0	0	0	0

Figure 3. Gini Index in the TF model, B=1

p \ r	0.0	0.2	0.4	0.6	0.8	1.0
0.0	0.52	0.52	0.50	0.50	0.50	0.50
0.2	0.50	0.47	0.49	0.49	0.48	0.47
0.4	0.53	0.48	0.46	0.49	0.46	0.46
0.6	0.50	0.47	0.47	0.44	0.42	0.44
0.8	0.50	0.47	0.44	0.42	0.41	0.41
1.0	0.51	0.47	0.42	0.37	0.37	0.35
B =	1	1	1	1	1	1

Figure 4. Gini Index in the YS model, B=1

p \ r	0.0	0.2	0.4	0.6	0.8	1.0
0.0	0.64	0.63	0.63	0.65	0.62	0.64
0.2	0.63	0.60	0.55	0.56	0.57	0.58
0.4	0.65	0.52	0.49	0.49	0.49	0.50
0.6	0.62	0.48	0.45	0.43	0.42	0.42
0.8	0.65	0.44	0.36	0.36	0.32	0.35
1.0	0.63	0.39	0.32	0.27	0.25	0.24
B =	1	1	1	1	1	1

Figure 5. Gini Index in the TF model , Dynamic r

p \ r	0.0	0.2	0.4	0.6	0.8	1.0
0.9	0.62	0.51	0.43	0.39	0.37	0.35
0.9	0.64	0.52	0.42	0.39	0.37	0.35
0.9	0.65	0.50	0.44	0.41	0.38	0.36
0.9	0.62	0.52	0.44	0.39	0.37	0.35
0.9	0.62	0.50	0.43	0.39	0.34	0.35
0.9	0.65	0.52	0.45	0.37	0.35	0.39
B =	0	0	0	0	0	0

p \ r	0.0	0.2	0.4	0.6	0.8	1.0
0.9	0.49	0.46	0.43	0.39	0.38	0.37
0.9	0.51	0.47	0.42	0.40	0.38	0.39
0.9	0.51	0.46	0.43	0.40	0.38	0.37
0.9	0.51	0.45	0.43	0.41	0.39	0.37
0.9	0.53	0.47	0.43	0.40	0.36	0.37
0.9	0.50	0.45	0.42	0.40	0.38	0.39
B =	1	1	1	1	1	1

Figure 6. Gini Index in the TF model, Dynamic B

p \ r	0.4	0.5	0.6	0.7	0.8	0.9
0.4	0.56	0.55	0.53	0.54	0.52	0.55
0.5	0.47	0.47	0.45	0.45	0.44	0.45
0.6	0.43	0.43	0.43	0.41	0.42	0.42
0.7	0.45	0.44	0.46	0.43	0.42	0.44
0.8	0.43	0.42	0.40	0.43	0.41	0.41
0.9	0.41	0.43	0.45	0.45	0.43	0.43
B =	0	1	2	3	4	6

Figure 7. Gini Index in the YS model, Dynamic B

p \ r	0.4	0.5	0.6	0.7	0.8	0.9
0.4	0.95	0.95	0.95	0.96	0.96	0.95
0.5	0.46	0.48	0.46	0.47	0.48	0.45
0.6	0.39	0.38	0.38	0.36	0.36	0.34
0.7	0.34	0.34	0.32	0.33	0.31	0.32
0.8	0.32	0.31	0.32	0.31	0.30	0.30
0.9	0.32	0.30	0.29	0.30	0.29	0.29
B =	0	1	2	3	4	6