Geometric Asset Exchange Model

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Abstract

The simple Asset Exchange Model was introduced by econophysicsts in the 1990s. It models the economy as a simple stochastic system where agents interact with each other by trading. The parameter of interest in this model is the wealth distribution. The Asset Exchange Model is analogous to the Kinetic Theory of gases. This paper looks at a network theory approach to the Asset exchange model. The aim is to create a generalized computational model onto which economic problems can be mapped.

Motivation

Classical theories in economics begins at the microeconomic foundations.
The economy is a complex, dynamic stochastic system. The agents in a system interact dynamically and the system evolves over time. The agents interact via a specific structures (markets). This was a key feature which was not present in the simple Asset Exchange Model.

The Asset Exchange Model is a simple stochastic system where agents interact with each other. During each interaction, one agent loses while the other agents win. The amount of wealth traded can be additive (a set of of wealth is traded) or multiplicative (a percentage of the poorer agents wealth is traded). The aim of this model is to analyze how the agents' wealth evolves over time.

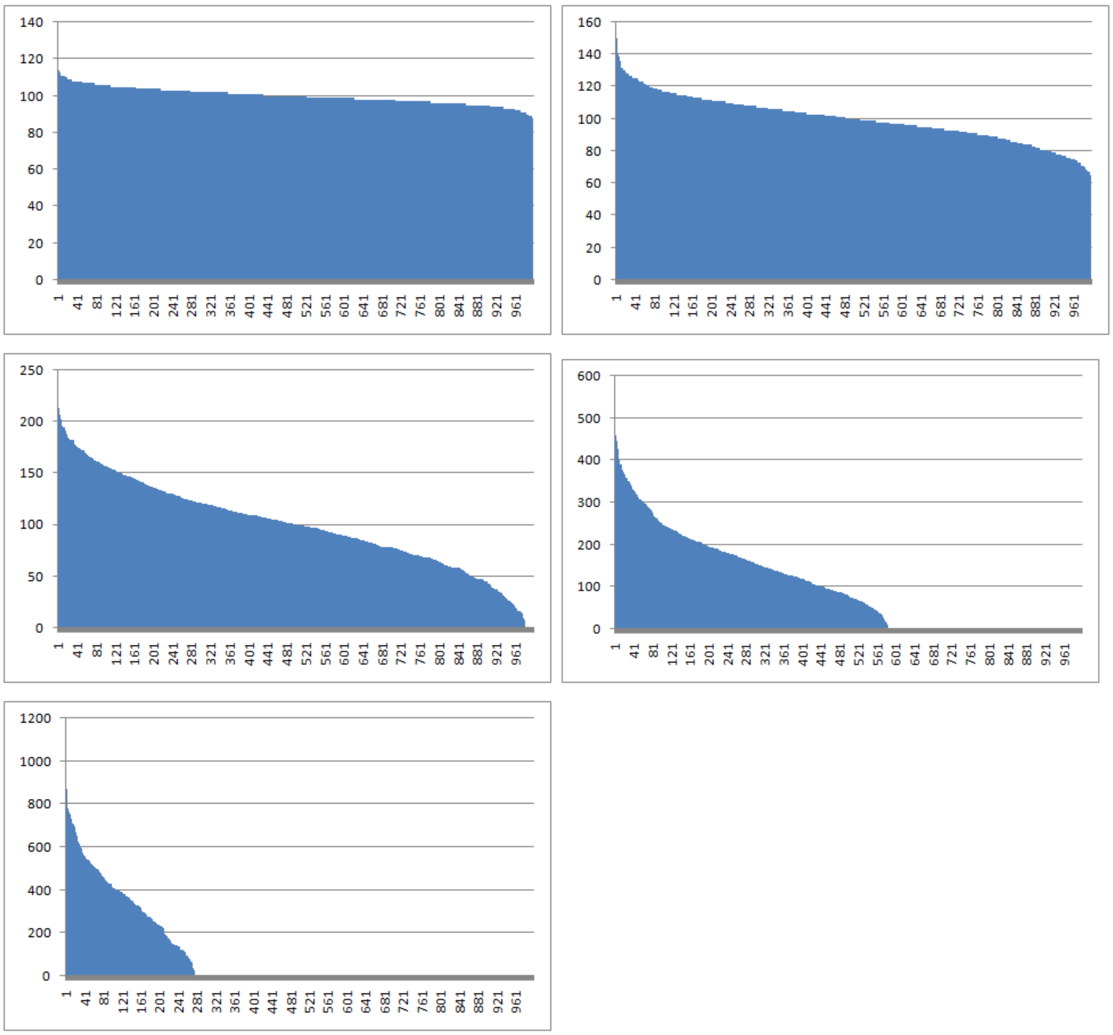
The Geometric Asset Exchange Model (GAEM) is similar to the Asset Exchange Model. Here the economy is divided into different sections. There is interaction between agents within a section and there is interaction between agents from different sections.

Ground State of the Geometric Asset Exchange Model

In this paper we look at the simplest version of the Geometric Asset Exchange Model. This consists of dividing economy into two sections, labelled Red and Blue. To reduce the volatility in the system we use an additive trading parameter.

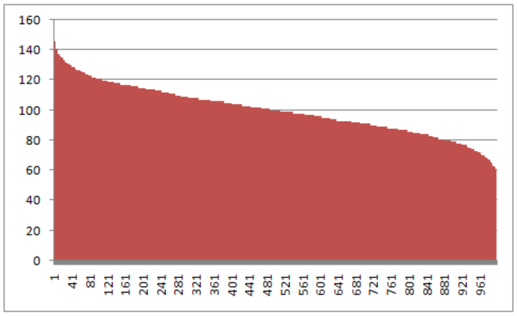
The important questions are: When is there a transfer of wealth between the two sectors? What factors affect the failure rates of agents? What factors affect wealth condensation?

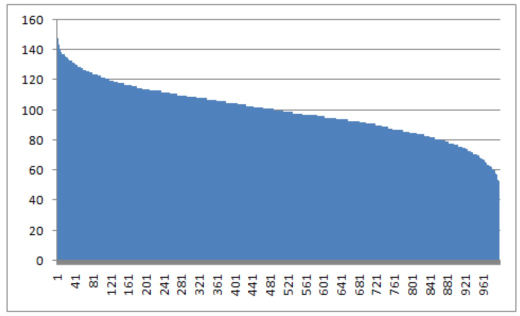
Case 1: 1 sector economy with additive exchange model
In this case we only have the economy as a whole without any divisions. The simulation is run using 1000 agents. Each agent begins with 100 units of Wealth and the trading parameter is 1 unit.

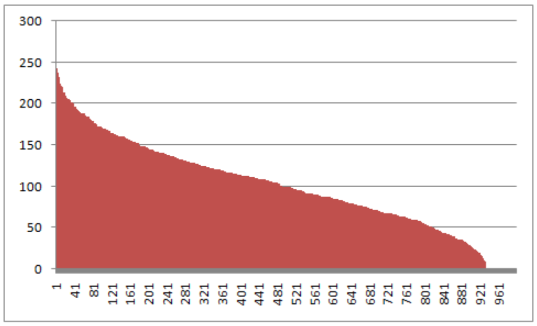


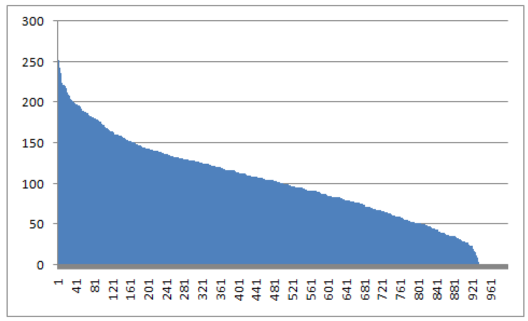
The graphs shows the wealth distribution at 10^4,10^5,10^6,10^7 and 10^8 cycles of trades.
The wealth inequality seems to increase over time. At 10^6 cycles we can see that certain agents have failed, i.e. they do not have enough wealth to continue trading
We can see that over time all the wealth seems to condense onto a small number of agents.

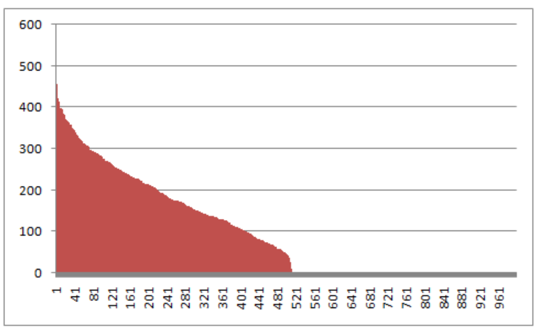
Case 2: Intersection trading with unbiased trading parameters
The economy is divided into two sections with 1000 agents each. The agents all begin with 100 units of wealth and exhange 1 unit per transaction.

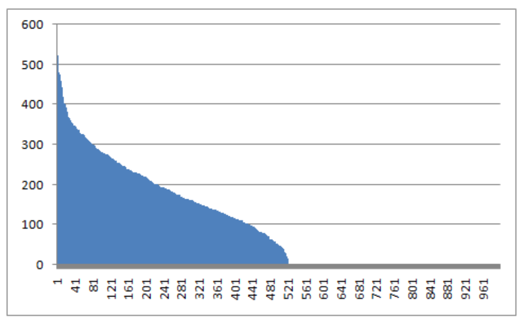






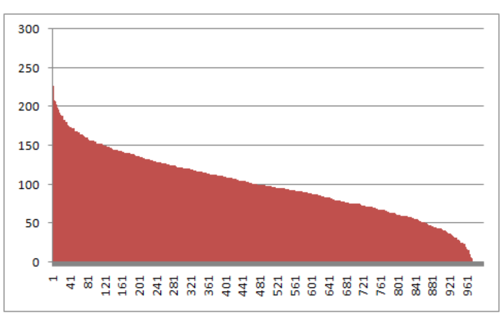


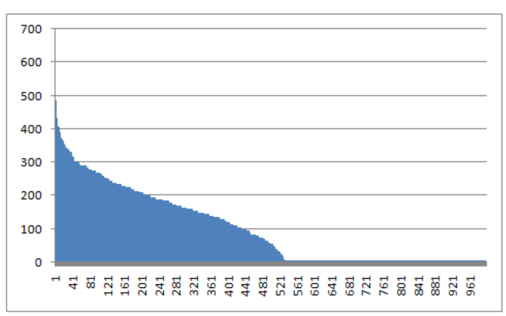


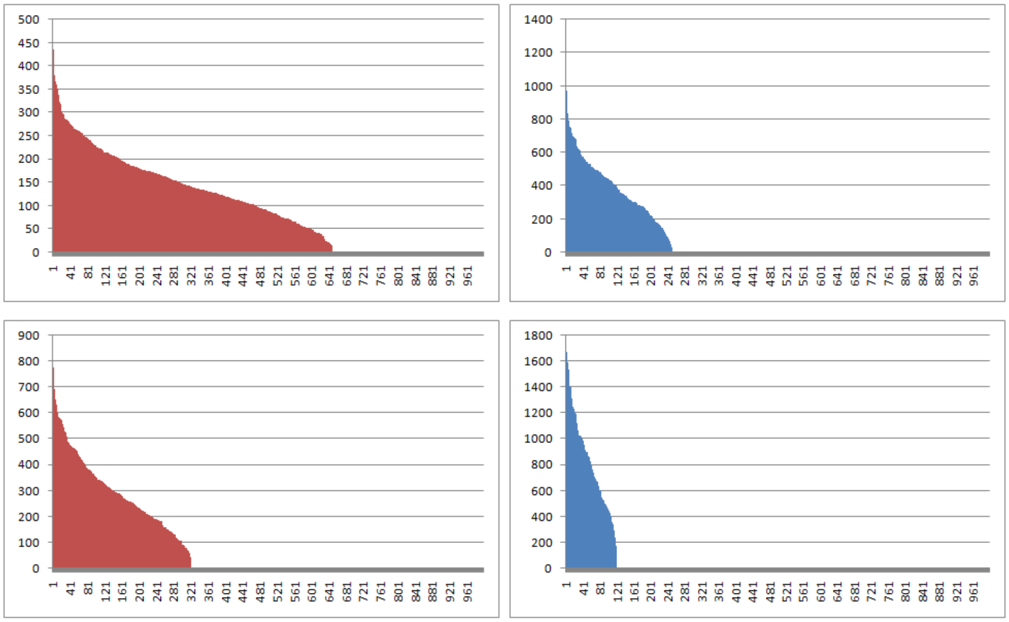


The wealth distribution evolves in time in the same way as case 1. Section 1(Red) and Section 2(Blue) closely track each other. Wealth condensation still persists.

Case 3: Intersection trading parameter with biased trading
The economy is divided into two sections with 1000 agents each. The agents all begin with 100 units of wealth. The trading parameter within Section 1 (Red) is 1 unit, the trading parameter in section 2 (Blue) is 10. The trading parameter between the two sections is 5.







The graphs shows the wealth distribution at 10^5, 10^7 and 10^8 cycles of trades.
Section 1(Blue) has the higher trading parameter and this causes wealth condensation to occur faster. Due to Section 1(Red) interacting with Section 1(Blue), the wealth inequality tends to increase quicker than before.
Also there is a small inflow of wealth from Section 1(Red) to Section 2 (Blue).
Section 2 increases a 4% growth whereas section 1 experiences a 4% contraction.

When the simulation is run for longer number of cycles, Section 2 (with the higher trading parameter) experiences a more significant transfer of wealth. Section 1 also experiences a greater wealth inequality.

This is an interesting observation and can be further explored in the future.

Summary and Conclusion

Wealth condensation increases with number of time steps. There exists a power law which gets steeper with time. Increasing the number of agents in the system gives it greater stability; i.e. the rate of agent failure decreases significant.
Greater volatility leads to faster rate of wealth condensation. In Case 3, it was observed that using a high trading parameter for Section 2 introduces greater volatility into the system. This causes Section 1 to have greater wealth condensation.

Future Projects

Incorporate Taxation, Growth Rate, Failure Sites into the Geometric exchange model. The key aim is to observe how introduction of a new parameter (such as taxation) affects other sections within the economy.

Use machine learning algorithms for the economy to simulate the stock exchange.

Find an analytic solution for the Geometric Asset Exchange Model. For the Geometric Asset Exchange Model for additive exchange, we can start with a truncated random walk.