

Re-implementing Lux's Financial Markets model

MODEL ODD

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- **Purpose and Model Description:** The model is an Agent-Based Model with agents following different types of trading strategies. The model tries to replicate phenomena observed in real markets such as Price bubbles, crashes and leptokurtic returns distribution.

- **Entities, State Variables, and Scales:**

- **Entities:** The only entities in the model are traders which are of 4

types :

1. Fundamentalists who make their decisions based on a “fair value” they assign to the asset.
2. Chartists who make their decisions based on trends and majority opinion. Chartists are further divided into two types : Optimists and Pessimists.
3. Contrarians, who always oppose the movements in price.
4. Followers, who always support the movements in price.

- **State Variables:**

The state variables for the traders include :

1. Their strategy (i.e. Chartist or Fundamentalist or Contrarian or Pessimist)
2. t_c : The percentage of portfolio value a Chartist spends at each time step.
4. γ : The intensity in their belief on the fair value for a fundamentalist trader
5. p_f : The fair value of the asset (only valid for fundamentalist traders)
6. s : The proportion by which a fundamentalist will discount its expected profit

The state variables for the environment i.e. the market include :

1. The current counts of all types of agents
2. α : The rate at which agents are removed from the market
3. f : The ratio of fundamentalists to other traders in the new agents which enter the market
4. p : The current price of the stock
5. β : The price adjustment speed
6. Constants $v_1, v_2, \alpha_1, \alpha_2, \alpha_3$

- **Scales:** One time step in the model will represent a day and the model will be run for a few years to generate a large enough dataset to do statistical analysis. There is no spatial component in the model and thus, no corresponding spatial scale. There will be around 500 agents in the simulation.

- **Process Overview and Scheduling:**

The model goes through discrete time steps. In each time step, traders decided the quantity of the asset to buy or sell. This is used to calculate the total excess demand which is then used to calculate the change in prices.

Once the price has been updated, each agent seeks out some other agent to meet with.

The agent may change its strategy or outlook after the meeting with some probability depending on the state of the system (This probability is an exponential function of the difference in profits between the two types of traders and the relative proportion of traders following their trading strategies. The relative weights for each of these factors are given by the constants $v_1, v_2, \alpha_1, \alpha_2, \alpha_3$). Once each agent has successfully met with some other agent, the next phase starts.

In this phase, a constant fraction of traders are removed from the market. In turn, new traders are added to the market (to keep the total number of traders constant). These agents are split between other traders and fundamentalists in the ratio specified by f . The chartists are split between optimists and pessimists in the ratio that they are already in the existing market.

Finally, a random 'news' is generated which is used to update the beliefs of the fundamentalists.

The end of this phase marks the end of a timestep.

- **Design Concepts**

Emergence - Above complex system give rise to emergent phenomena such as bubbles and crashes occasionally. It occurs because of continuous change in the psyche of the agents and interaction among them. Too much optimism in the system will lead to a bubble and too much pessimism will lead to a crash. Fundamentalists will sell during a bubble and buy after the crash.

Adaptive behavior - The system and the agents within adapt to any new information and based on that make their trading decisions. A fraction of chartists tend to adapt and become a fundamentalist in the system.

Interaction - Traders meet with other traders frequently and make their opinions about the market.

Stochasticity - Every trader in the system has a different psyche and they have varied decisions when it comes to trading. The meeting of traders is also at random.

Observation - The price of an asset is our primary observation. To gain more information we can also observe the ratio of different traders.

- **Initialization**

The model is initialized with 1000 traders with the following split : 500 fundamentalists, 100 contrarians, 100 followers, 100 optimistic chartists and 200 pessimistic chartists. The values of the other parameters are as follows :

Agent variables :

1. $t_c = 0.002$

2. γ randomly initialized between 0.01 and 0.1

3. $p_f = 110$

4. $s = 0.5$

Environment variables :

1. $a = 0.05$

2. $f = 0.5$

3. $p = 100$

4. $\beta = 0.0005$

5. $v_1 = 1$

6. $v_2 = 1$

7. $\alpha_1 = 0.02$

8. $\alpha_2 = 0.07$

9. $\alpha_3 = -0.07$

- **Input Data**

This model uses no additional input data.