Application: A very simple financial market with zero intelligence agents

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You are invited to develop a NetLogo model that represents the very simple financial market that is described below.

1 Elements of the model

The market of a financial asset contains $n \in [100, 1000]$ zero-intelligence agents. In each period, $m \in [40, 200]$ agents, randomly selected from the set of n agents, participate to the market. Each of these m agents decides, in a equiprobable way, between proposing to make a transaction ($talk = 1$) or not ($talk = 0$). Again in an equiprobable way, each participating agent decides to speak on the supply (ask) or the demand side (bid) of the market, and proposes a volume l of assets, where this number is drawn randomly from the uniform distribution on the interval $[1, l_{max}], l_{max} \in [2, 200]$. The price of the asset evolves as a function of the excess demand on the market :

$$p_{t+1} = p_t \times exp\left(\left(\sum bid - \sum ask\right) \times \eta\right)$$

$\eta \in [0, 0.00005]$ represents the granularity of the market in terms of price adjustment. The initial price of the asset is a parameter of the model: $p_0 \in [10, 100]$.

Model's aim is to represent the price dynamics under these very simple market conditions, given the values adopted by the user for the model parameters.

2 NetLogo program

The graphical interface should contain the following elements:

- The World where we will place the agents. The world's size will be $33 * 33 = 1089$ cells (Origin=Center; $max - pxcor = 16$; $max - pycor = 16$; Patch size = 10).
- A slider for selecting n and we will call this parameter $number - agents$ in the Netlogo program.
- A slider for selecting m and we will call this parameter $number - speakers$ in the Netlogo program.
- A slider for selecting l_{max} and we will call this parameter $max - order - size$ in the Netlogo program.
- A slider for selecting p_0 and we will call this parameter $initial - price$ in the Netlogo program.
- A slider for selecting η and we will call this parameter eta in the Netlogo program.
- A monitor indicating the current price, p_t.
- A monitor indicating the current level of total asks.
- A monitor indicating the current level of total bids.
- A plot showing the evolution of the market price in time.

- A histogram that shows the distribution of the returns from the start of the market:

$$rent_t = Ln(p_t) - Ln(p_{t-1})$$

- A button «Setup» that triggers the execution of the ***setup*** procedure (see below).
- A button «Go» that continuously call the ***go*** procedure. To stop the program, the user will just push again this button.

The code of the model should contain:

- Declaration of the global variables, and the agent's variables.
- A ***setup*** procedure that initializes the model, and that creates the agents, with an initial color green and a form «person». Agents are distributed randomly on the World.
- A ***go*** procedure that contains the instructions corresponding to the operations that take place in each market period, and that:
  - randomly selects the m participating agents, and asks them de make an order decision, by calling a procedure called `make-decision`. The agent first choses to speak or not and, if it speaks, the side of the market and the volume l.
  - changes the colour of the agent as a function of its decisions: green if it does not speak, red if it speaks on the demand side, yellow it speaks on the supply side.
  - computes the new market price by calling a procedure named `execute-orders`
  - resets the decisions of the agents by calling a procedure `cancel-orders`.

3 Experiments

Given the simplicity of the model we do not have a lot to experiment. We can nevertheless set the parameters of the model and check the long term evolution of the market ($ticks = 15000$):

1. Fix $n = 1000$, $m = 100, l_{max} = 200, p_0 = 100, \eta = 2.4E-5$ to begin with. Run the model several times and observe the price dynamics. What is your opinion about their behavior and volatility. Do we converge to an equilibrium? Does the time series look realistic, in comparison with what we have on financial markets?
2. Same questions with different values of η. What is the influence of this variable on the price dynamics and the distribution of returns?
3. Same questions for $n = 1000$, $m = 40, l_{max} = 200, p_0 = 100$.
4. and $n = 1000$, $m = 40, l_{max} = 20, p_0 = 100$.

NetLogo Instructions that should be explored for this model: `n-of`, `list`, `ln`, `histogram` (see the dictionary and the *Programming guide*).