Modelling Market Dynamics with a "Market Game"

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Keyword: Market dynamics, Minority game, Complex adaptive system, Multi-agent simulation

1 Backgrounds

In the financial market, traders, especially chartists, decide to buy or sell according to a signal typically from past price movements. To analyze the market dynamics as a system, such micro-level decision-making process and behavior have to be taken into account.

To deal with this kind of micro-level feature, a minority game introduced by Challet and Zhang [1] is one of the representative methods. It is an agent-based market model that generalizes the situation of competition for limited resources illustrated by Arthur as "The El Farol Bar Problem" [2]. Even though minority game has been regarded as a toy model, it includes the basic mechanism for learning and adaptation. Hence, many artificial market models based on minority game have been proposed especially in the area of econophysics in recent years.

On the other hand, there are some skeptical voices against applying this minority game as a market model. It is because the minority game is too abstract to model the above-mentioned decision-making process which involves signal waiting in both buying and selling assets. Furthermore, some processes in a minority game are stochastic, it requires lots of manipulations to the original settings for the reproduction of the stylized facts [3], [4].

Therefore in this research, we try to build a deterministic market model named "Market Game", which reflects the realistic signal waiting behavior of traders and reproduce the stylized facts of price returns as well. The proposed market game could have a potential to become a new alternative method to analyze the influence of micro-level behavior to market dynamics.

2 Model

Like minority game, the market game is designed with holding simpleness and high extensibility.

Each agent chooses to buy, sell, or hold by referring to a "history" which represents past price changing patterns: up, down, and flat. Agents start a trade with a buy or sell position and have to end up with the opposite position they had in the beginning when they found specific patterns in the history. If signals are not found, agents choose to hold to stay away from trades.

Agents use "strategies" when they make a decision similar to a minority game. Multiple strategies are given to all agents in the beginning of the game, and they accordingly decide which strategies to use through their past investment performances in order to expand their profits.

Another remarkable feature is that agents have "capital" which increases or decreases according to their performances. If an agent has no capital when he begins ordering, he has to withdraw from the market. To fill the absence of a bankrupted, a new agent is substituted to sustain the market size.

3 Results and Discussions

One of the stylized facts about the market dynamics is leptokurtosis: a higher peak and fatter tails than a Gaussian distribution and good fit of cumulative distribution with power-law function. Market game can reproduce this feature as shown Figure.1 and Figure.2.

We are still working on about the reproducibility regarding other stylized facts. The influences of different parameters are also being analyzed.

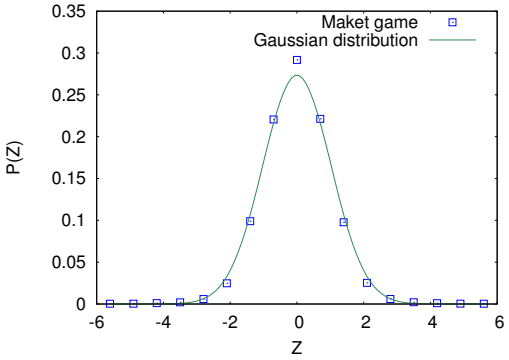

Figure1: High peak.

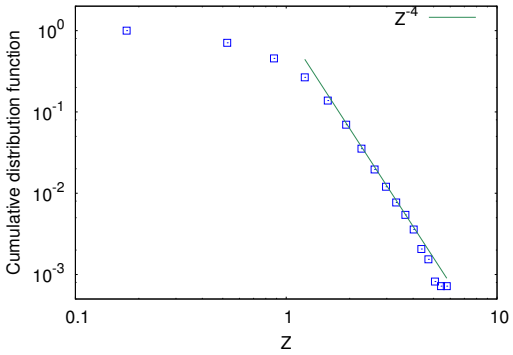

Figure2: Good fit of CDF with power-law function.

Figure.1 Comparisons of the every time step probability density function for price changes by the market game (square dots) with the Gaussian distribution (solid line). Normalized values are used for this plot.
Figure.2 Log-log plot of the cumulative distribution of normalized returns by the market game (square dots) . It fits the power-law distribution of Z^{-4} (solid line).

References

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