ANALYSIS OF THE MECHANISM BEHIND THE LOG-PERIODIC PRICE OSCILLATIONS PRIOR TO A MARKET CRASH THROUGH MULTI-AGNET SIMIULATION

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The research is aimed to identify the origin of the log-periodic price oscillations prior to a market crash through multi-agent simulation. A market crash can be interpreted as the consequence of the market system undergoing the unstable state where the system becomes very sensitive to an otherwise innocuous small global perturbation. In natural science (e.g. the study of earthquake), the instability of a system may manifest itself as the log- periodic oscillations of some observable appropriate to the system [1]. The observation in natural science combined together with the interpretation mentioned above lead to the search for the log-periodic signatures in the financial market. The study of the price patterns prior to the major market crashes indicates that a crash is preceded by the log-periodic oscillations of the price as a function of time, which supports the idea that a market crash is caused by the instability of the system [2]. Sornette attributes the origin of the instability of the market system to the herding behavior of the traders. When the tendency of traders to herd is strengthened, a large cluster of the traders forms sharing the same buy/sell opinion, which leads to a large price fluctuation. Based on the idea, Sornette developed a theory to describe the price patterns prior to a crash. In the theory, the existence of a network connecting the traders is assumed through which they imitate each other's opinion. Also, the strength of the tendency of the traders to imitate others is assumed to increase linearly with time. With the additional assumption that the network is a scale free network [3], a diamond lattice network (see Fig 1), Sornette was able to derive a stochastic equation which predicts the log-periodic oscillations of the price [4]. However, the mathematical model does not explain in the level of the traders how the specific topology of the network leads to such an opinion formation process which gives the rise to the log-periodic oscillations of the price. The goal of the current study is to reveal the specific way the fractal topology of the network affects the opinion formation process and leads to the log-periodic oscillations through multi-agent simulation. The model employed for the simulation is on the line of the spin model [5] with several modifications. The traders in the model

are connected by a diamond lattice network, and classified into two categories. The first type of trader is an imitator who decides his or her buy/sell opinion at time t comparing his or her idiosyncratic signal ε_i with the opinions of other traders connected to him or her through the network. The strength of the tendency to imitate others is controlled by parameter K. The second type of trader is an informed trader who decides his or her opinions based on the information he or she receives. In the simulation, the control parameter K is set to increase proportionally to the time step, reflecting the assumption Sornette made in the development of his theory. The informed traders constitute only a small fraction of the entire traders, and have only a small number of links to other traders. The opinions of the informed traders are fixed from the beginning through near the end of the simulation. The informed traders change their opinions in concert near the end of the simulation. The purpose of such a model setting is to mimic the behavior of the informed traders in the real world during the time of a market bubble and its end. For several initial conditions, roughly log-periodic oscillations are observed in the simulation prior to a large price drop (see Fig 2). At this stage, we could infer that the observed log-periodic oscillations is attributed to the competition between the slow but persistent propagation of the opinions of the informed traders to the whole network, and the fast but tentative formation of local clusters around imitative traders with many links to other traders. A further investigation of the detailed mechanism is to be done in the future with the help of visualization of the dynamics of the opinion formation on the network.
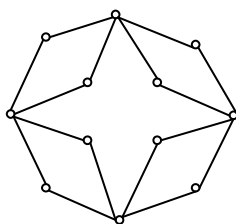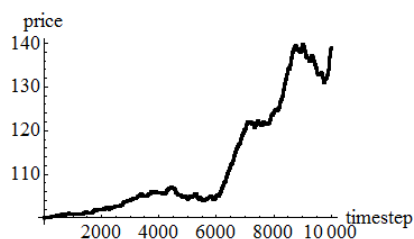
Fig. 1. Diamond lattice network

Fig. 2. a simulation result

Keywords
market crash, log-periodic oscillations, scale free network, multi-agent simulation

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