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Agent-based model with heterogeneous fundamental prices

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Abstract

In this paper, we investigate the properties of the return time series generated by a multi-agent-based model for financial markets. Our model is a variant of the grand canonical minority game model where the agents behave as producers and a fraction of them is allowed to shift their strategy in order to act opportunistically as fundamentalists. Our model assumes the existence of speculators with heterogeneous beliefs about the fundamental price. Our simulation results are robust to reproduce stylized facts as volatility clustering, fat tail, uncorrelated return and slowing decay on the absolute return.

Keywords: Grand canonical minority game; Stylized facts; Heterogeneity in fundamental prices

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1. Introduction

Several analyses from empirical data have revealed that financial times series of returns are generated by non-Gaussian processes [1–4]. Surprisingly, from the statistical point of view different markets as commodities, stocks or currencies exhibit similar qualitative features which are known as stylized facts. These main features which are referred to as stylized facts are volatility clustering [1,5], fat tails in the probability distribution of returns [5], absence of autocorrelation of returns, a slow decaying of the autocorrelation function of absolute returns [6,7], long memory in buy/sell [8], excess volatility, which concerns the difficult to justify the level of large variability (positive and negative) in the asset return in terms of fundamental economical variables [9].

Recent studies have developed mathematical models to better understand the universal phenomena of these financial data, such as levy processes, stochastic volatility models and multi-fractal processes [10,11]. Alternatively, some models support the idea that the market is a complex interacting system. In that context, a variety of microscopic agent-based models was proposed to find out the common mechanisms which are responsible for stylized facts in financial market [12–14].

One of the most successful multi-agent models for financial market is the so-called grand canonical minority game (GCMG) [15–19]. According to this approach, the stylized facts arise as a critical phenomenon, which takes place in the critical region separating an ergodic from a non-ergodic regime [20]. Close to the critical point, the agents self-organize to exploit all available information in the market in order to minimize the volatility, and in that way the market has informational efficiency. Remarkably, the GCMG is very simple and deals with only a few parameter. The recent investigations of the GCMG model have shown a variety of interesting properties as phase transition, crashes and self-organized criticality [21–23]. Because of its simplicity, the model can be studied analytically [24–26]. Nevertheless, the emergence of stylized facts in the GCMG does not take place easily, it depends on the realization, even when we consider the same set of parameters.

Many authors have introduced models with speculators that believe in the existence of a fundamental price p_f of the asset, which could also be adapted during the price's evolution [14,19]. In this paper, we address the model where fundamentalists disagree about fundamental price. We show that, when fundamentalists have heterogeneous beliefs concerning the fundamental price, stylized facts arise for a large range of the parameters set. Actually, the main assumption in the MG is that agents have bounded rationality, which reflects their limited cognitive abilities. Although the agents receive the same information at each timestep, they process information in a different way, because of a high degree of heterogeneity in their strategies. It seems straightforward to consider heterogeneity in the beliefs of agents about the fundamental price and so to investigate their role in the pattern formation of price fluctuations. Here belief is a subjective opinion that arises from traders' judgments about the fair level of price based on their perception, budget or need. In the economics behavioral literature, belief is an element in the formation of the so-called preferences.