Extreme Events in Small-Scale Minority Games

Abstract

A striking feature of financial markets are the heavy tailed distributions of returns: Price changes that are orders of magnitudes larger than the typically observed ones occur much more frequently than to be expected from a Gaussian distribution. On the one hand, agent based models like the minority game are used to explain extreme price movements as collective phenomena from a competition of strategies. On the other hand, stochastic models are used for characterizing statistical properties of price fluctuations. Many of these models are based on the efficient market hypothesis. It is often presumed, that traders behave maximally rational and that price fluctuations are natural consequences of very effectively balancing out arbitrage opportunities. However, the high frequency of extreme price movements like crashes seems to contradict market efficiency. Such events are often believed to be either related to malign behavior of few potent market participants or to irrational herding effects of speculators. Further, studies in behavioral economics suggest that humans may not behave like ideal rational traders. However, subjects are typically studied in isolation or in very small interacting groups.

We investigated, whether it is possible to study large collective phenomena in model markets experimentally with moderately sized groups of participants. We found, that many approaches towards understanding price fluctuations can be mapped in a mathematically precise way to a particularly simple and very illustrative game. The rules correspond to a modified minority game which is combined with a simple yet effective visualization that allows subjects to easily understand the game.

Strong herding behavior robustly emerged even with just 10 to 15 players. However, this effect was found not to contradict collective market efficiency. On the contrary, herding is caused by subjects exploiting predictable price changes. Simulations of larger markets consisting of stochastic agents modeled after the experimental findings exhibit power-law log-return distributions and volatility clustering. We also investigated an online game where different subjects competed against adaptive, partially predictable virtual players over the course of several months. Subjects were able to successfully exploit the virtual players and the resulting time series again exhibit the aforementioned stylized facts.

We are currently in preparation of experiments with larger numbers of participants via the internet. Since the game is entertaining to play, it can further be used to playfully convey scientific approaches as well as basic insights of game-theoretical approaches in economics.

Update: The game can be played at http://seesaw.neuro.uni-bremen.de