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Greed, fear and stock market dynamics

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Abstract

We present a behavioral stock market model in which traders are driven by greed and fear. In general, the agents optimistically believe in rising markets and thus buy stocks. But if stock prices change too abruptly, they panic and sell stocks. Our model mimics some stylized facts of stock market dynamics: (1) stock prices increase over time, (2) stock markets sometimes crash, (3) stock prices show little pair correlation between successive daily changes, and (4) periods of low volatility alternate with periods of high volatility. A strong feature of the model is that stock prices completely evolve according to a deterministic low-dimensional nonlinear law of motion.

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1. Introduction

Stock markets are driven by the fast and hectic trading of a large number of traders. Although the behavior of stock prices is quite complex, certain universal features may be identified [1–3]. For instance, we observe a positive price trend in the long run which is occasionally interrupted by crashes. Moreover, log price changes

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(i.e., returns) are uncorrelated while temporal independence of absolute returns is strongly rejected.

According to classical finance theory [4], the statistical properties of price fluctuations are wholly caused by those of the underlying fundamental process. For instance, volatility clustering arises since the intensity of news varies over time. A more convincing explanation is provided by behavioral models that take into account the trading decisions of heterogeneous agents (for surveys see [5–8]). Note that the trading behavior of agents is at least partially observable and thus may be approximated. For example, some traders base their trading decisions on technical analysis rules such as moving averages whereas others simply expect prices to return towards fundamental values. Complex (chaotic) price motion may occur due to nonlinear interactions between the agents. If one adds dynamic noise to these setups, they may even be able to replicate some of the aforementioned stylized facts [9–12].

This paper aims at developing a deterministic behavioral stock market model in which agents are influenced by their emotions. To be precise, the trading activity of the agents is characterized by greed and fear. They optimistically believe in booming markets, but panic if prices change too abruptly. In addition, the agents switch between two activity levels. If market historical volatility is low, they are rather calm and vice versa. Although the model is deterministic, it replicates several aspects of actual stock market fluctuations quite well. For instance, we observe the absence of autocorrelation in raw returns but significant autocorrelation in absolute returns.

We think that having a good understanding of what is going on in financial markets is quite important. On the one hand, it may allow us to develop better investment strategies. Some studies have recently made interesting progress in predicting the course of the stock market [13]. On the other hand, it may help regulators to control the markets. One may, for instance, use these models as computer laboratories and test whether mechanisms such as transaction taxes are able to reduce volatility [14–16].

The paper is organized as follows. In Section 2, we present our model and in Section 3, we discuss our results. The last section concludes the paper.

2. The model

In our model, prices adjust according to a log-linear price impact function. Such a function describes the relation between the number of assets bought or sold in a given time interval and the price change caused by these orders [17].¹ Accordingly, the log of the price in period $t + 1$ is given as

$$P_{t+1} = P_t + D_t, \quad (1)$$

where D denotes the excess demand. Clearly, excess buying drives the prices up and excess selling drives them down.

¹However, recent empirical evidence indicates that the price impact function displays a concave curvature with increasing order size, and flattening at larger values [18].

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