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# Detecting the traders' strategies in minority–majority games and real stock-prices

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**Abstract**

Price dynamics is analyzed in terms of a model which includes the possibility of effective forces due to trend followers or trend adverse strategies. The method is tested on the data of a minority–majority model and indeed it is capable of reconstructing the prevailing traders' strategies in a given time interval. Then we also analyze real (NYSE) stock-prices dynamics and it is possible to derive an indication for the "sentiment" of the market for time intervals of at least one day.


*Keywords:* Complex systems; Time series analysis; Financial data; Economic systems

## 1. Introduction

The simplest representation of price dynamics is usually considered as a simple random walk (RW). It is easy to realize, however, that many important deviations are also present. The most studied are the problems of the "fat tails" (in the distribution of price returns), the volatility clustering and various other elements related to the nonstationarity of the process [1,2]. The arbitrage condition implies that no simple correlations can be present. A large effort is therefore devoted to the identification of complex correlations of various types. These correlations arise from the collective behavior of traders, which lastly, define the price.

In this perspective a simple classification of trading strategies can be made in terms of trend followers or trend adverse. Usually these different strategies are taken as input in models which represent the behavior of traders.

Here we would like to consider the complementary point of view. Namely, given a time series, is it possible to identify, from the data, the strategies of the traders? In order to address this question we use a new approach which is based on a RW plus a force which depends on the distance of the price from some suitable moving averages [3,4]. This idea is that, with such an analysis, one can identify the "sentiment" of the market in a given time interval.

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In this paper, we first perform some statistical tests of the method to clear its signal to noise ratio. Then we apply the method to time series generated by a minority–majority model [5]. This is an important test because, in this case, one knows the prevailing strategy of the traders. The results are rather encouraging because the method can indeed identify these strategies. Finally we apply the method to real stock prices data of the NYSE and the preliminary results show that it is possible to derive statistically significant information on the prevailing trading strategy for a single day or larger time periods.

## 2. The effective potential model

In recent papers [3,4], the idea that the stock-price dynamics can be influenced by a moving average of the price itself in the previous time steps has been introduced. Hence, at every time step $t$, one can introduce a moving average of the previous $M$ time steps

$$P_M(t) = \frac{1}{M}\sum_{\tau=0}^{M-1} P(t-\tau). \tag{1}$$

In Fig. 1 is plotted the time evolution of a RW with Gaussian random noise together with the moving average of the price. One can investigate if there could be a relation between the next price increment $P(t+1)-P(t)$ and the difference $P(t)-P_M(t)$. The simplest assumption is to adopt a linear dependence

$$P(t+1)-P(t) \propto P(t)-P_M(t). \tag{2}$$

In this case, the price dynamics can be described in terms of a RW with the existence of a linear force. This force can be either repulsive or attractive depending on the sign of the constant of proportionality between $P(t+1)-P(t)$ and $P(t)-P_M(t)$. Therefore, the dynamical equation of the price is a RW with the presence of a force that is the gradient of a quadratic potential $\Phi$ [4],

$$P(t+1) = P(t) - b(t)\frac{\mathrm{d}}{\mathrm{d}P(t)}\Phi(P(t)-P_M(t)) + \omega(t), \tag{3}$$

where $\omega(t)$ corresponds to a random noise with unitary variance and zero mean. $P_M(t)$ is the moving average described in Eq. (1).

The potential $\Phi$ together with the pre-factor $b(t)$ describe the interaction between the price and the moving average. In simple assumption of a linear force [4], $\Phi$ results to be quadratic:

$$\phi(P(t)-P_M(t)) = (P(t)-P_M(t))^2. \tag{4}$$

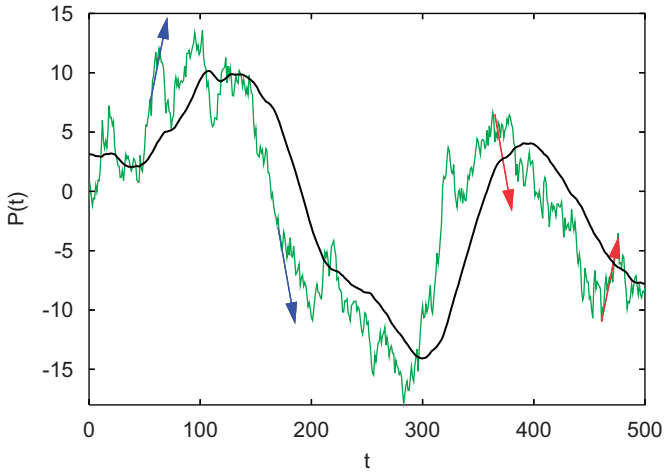


Fig. 1. Example of a model of price dynamics (in this case a simple RW) together with its moving average defined as the average over the previous 50 points. The idea is that the distance of the price from its moving average can lead to repulsive (blue arrows) or attractive (red arrows) effective forces.