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Who wins? Study of long-run trader survival in an artificial stock market

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Abstract

We introduce a multi-asset artificial financial market with finite amount of cash and number of stocks. The background trading is characterized by a random trading strategy constrained by the finiteness of resources and by market volatility. Stock price processes exhibit volatility clustering, fat-tailed distribution of returns and reversion to the mean. Three active trading strategies have been introduced and studied in two different market conditions: steady market and growing market with asset inflation. We show that the profitability of each strategy depends both on the periodicity of portfolio reallocation and on the market condition. The best performing strategy is the one that exploits the mean reversion characteristic of asset price processes.

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1. Introduction

Agent-based simulation of financial markets is a rapidly growing field [1]. In previous works [2,3], we introduced the Genoa Artificial Stock Market (GASM), a computer simulator of financial markets which is able to reproduce main stylized facts present

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in real market, i.e., volatility clustering and fat-tailed distribution of returns with very simple assumptions about the behaviour of agents and a realistic market microstructure. The system is able to keep track of every agent portfolio and the agents are endowed with limited financial resources. In the first version of GASM, only one risky asset was traded in exchange for cash. In this paper, we present a multi-asset artificial market and we study the long-run performance of different trading strategies in a competitive market with finite wealth.

2. The market microstructure

Let N be the number of risky assets traded in the market and let us denote the kth risky asset with the superscript k. Let M be the total number of traders operating in the market; the ith trader is denoted with the subscript i.

At every discrete time step h, agent i knows his amount of cash $c_i(h)$ and the number of stocks $a_i^k(h)$ of the risky asset k held in the portfolio. If $p^k(h)$ is the market price of the risky asset k at time step h, the risky wealth $W_i^r(h)$ owned by trader i at time step h is $W_i^r(h) = \sum_{k=1}^N a_i^k(h) \cdot p^k(h)$ and the total wealth is $W_i(h) = c_i(h) + W_i^r(h)$.

The weight $\omega_i^k(h)$ of asset k in the portfolio of agent i at time step h is given by $\omega_i^k(h) = p^k(h) \cdot a_i^k(h)/W_i^r(h)$. It is worth noting that $\sum_k \omega_i^k = 1$ for all i by definition, and we impose that $\omega_i^k \geqslant 0$ for all i and for all k (short positions are not allowed).

At every time step, agent i always tries to allocate a fraction γ_i of his total wealth in the risky assets. In formulas, if $W_i(h)$ is the total wealth held by agent i at time step h, at time step $h+1$ the desired quantity to be allocated in the risky assets is $\hat{W}_i^r(h+1) = \gamma_i W_i(h)$, where the hat over the symbol indicates that it is a desired quantity but not the real amount of risky wealth at time step $h+1$. The trading strategy followed by agent i gives the desired weight $\hat{\omega}_i^k(h+1)$ of asset k in his portfolio at time step $h+1$; thus, the desired quantity of asset k is given by

$$\hat{a}_i^k(h+1) = \left\lfloor \hat{\omega}_i^k(h+1) \cdot \frac{\hat{W}_i^k(h+1)}{p^k(h)} \right\rfloor , \tag{1}$$

where the symbol $\lfloor .. \rfloor$ denotes the integer part. In order to fulfill the prescription of the followed trading strategies, agents issue buy or sell orders regarding contemporary all the assets traded in the market. The amount $\Delta_i^k(h+1)$ of the order issued by trader i at time step $h+1$ relative to asset k is

$$\Delta_i^k(h+1) = \hat{a}_i^k(h+1) - a_i^k(h) . \tag{2}$$

Δ_i^k is the difference between the desired amount of asset k at time step $h+1$ and the real amount held in the portfolio by agent i. If $\Delta_i^k > 0$ the order is a buy order, conversely if $\Delta_i^k < 0$ the agent issues a sell order.

As in the previous works [2,3], every order is associated with a limit price. We stipulate that buy (sell) orders cannot be executed at prices above (below) his