A multilayer approach for price dynamics in financial markets

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The dynamics of financial markets, with its erratic and irregular behavior at different time scales, has stimulated important theoretical contributions by several physicists and mathematicians since long time. In particular statistical physics has provided the newborn field of Econophysics with new tools and techniques that allow to model and characterize in a quantitative way the apparently unpredictable behavior of price and trading time dynamics. The recent use of agent-based approaches in financial markets models has also given very useful insights in understanding the often counterintuitive interactions among heterogeneous agents operating in realistic markets. Recently, herding and imitative behavior among agents has been successfully simulated with Self-Organized-Criticality (SOC) models and the adoption of random strategies has been shown to be an efficient and powerful way to moderate dangerous avalanche effects, diminishing the occurrence of extreme events. Often these models have adopted topologies like scale-free and small world networks to describe the social interaction among agents. Such topologies can be further refined for a detailed and realistic description. Very recently multilayer networks have been introduced for a more appropriate framework of several social networks. In this paper we use a multilayer network, to investigate price dynamics by means of an order book based on two assets. In order to simulate the operations of a financial market, the model here presented considers two layers: one for the exchange of information among traders and one for the order book mechanism. In brief, the role of the two layers is the following:

i) in the informative layer, according to the link configuration given by the network topology, agents collect and share information, therefore deciding their status (bidder, asker or holder) and the (ask or bid) price of their possible orders for the two assets, depending on the global price of the assets at time t and on the herding effect, which induces avalanches of identical investments;

ii) in the trading layer, investors put their orders in the order book, which provides a sort of compensation room to execute them, and the next global prices for the two assets emerge from the mutual interaction among all the agents.

This realistic framework produce interesting numerical results, which adhere to some typical features of real financial markets.

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