Stock market model first to reproduce main properties of the real market

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(PhysOrg.com) -- Since the early '90s, researchers have been developing simulations of financial markets with the goal to better understand market dynamics. While their models have improved since then to explain more features of the markets, no model has yet been able to fully reproduce the main statistical properties of financial markets in a single framework. In a new study, a team of researchers has developed an artificial stock market that, for the first time, can reproduce these main properties. Overall, the model shows how information exchange among agents can be used to understand the role of information in real markets.

The researchers, who are from various institutions in Italy, explain that their model consists of agents that are represented by nodes in a sparsely

connected graph. At the beginning of the simulation, each agent has the same amount of cash and stocks. The agents decide to trade an asset based on a value of their "sentiment" (ranging from -1 to 1, where -1 is a strong sell and 1 a strong buy). Agents' sentiments influence each other in a unidirectional way; that is, if Agent A influences Agent B, then Agent B does not necessarily influence Agent A. The stock price depends on the interaction between agents' sentiments and market feedback, and is fixed each day by a clearing house mechanism. In this way, all the properties of the artificial market originate directly from the interactions among agents.

"This interaction graph is the ultimate factor in determining the dynamics of the systems, and it demonstrates the effectiveness of our model in reproducing the main properties of the real market so accurately," Stefano Pastore of the University of Trieste told *PhysOrg.com*.

By performing simulations based on this model, the researchers found that the distribution of wealth tends to follow a Zipf power law distribution, where the rank of an agent is inversely proportional to the agent's wealth. As some agents become richer than others, they start showing behaviors that reinforce their growth. For instance, agents (such as big traders and banks) that are strongly influenced by their own previous sentiment are poorly influenced by the sentiment of their neighboring agents (such as individual investors). In particular, richer agents influence a larger number of agents with a higher strength, they do not account strongly for market behavior, and they aim to conserve their opinion.

In their simulations, the researchers found that the interaction between agents' sentiments yielded a price process that could reproduce the main properties of real markets. For example, the simulations produced fat tails of returns distributions, which can lead to large moves in the

market. Another feature produced by the simulations was volatility clustering, where large changes tend to be followed by large changes. These properties and other large market trends can occur due to the collective behavior of large groups of agents, reflecting a herding phenomenon, which results from the agents' interactions driven by the information network. As Pastore explained, understanding these properties could have several applications.

"[Artificial stock markets are] mostly devoted to develop and validate of stock market models, to provide tools for volatility forecast (risk analysis), to identify optimization procedure for parameter estimations, to set-up a learning suite and Interacting and strategy game (edutainment), to perform what-if analysis (e.g., trading strategies, risk management, law and regulations), etc.," Pastore said. "These objectives clearly point out the needs of adequate stock market models."

More information: S. Pastore, L. Ponta, and S. Cincotti. "Heterogeneous information-based artificial stock market." *New Journal of Physics* 12 (2010) 053035. DOI:10.1088/1367-2630/12/5/053035