Blueprint of a trend: How does a financial bubble burst?

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A joint study by academics in Switzerland, Germany and at Boston University sheds new light on the formation of financial bubbles and crashes. Wild fluctuations in stock prices caused by bubbles bursting have had a dramatic impact on the world economy and the personal fortunes of millions of us in the last few years.

The study "Switching processes in financial markets" will be published in the Proceedings of the National Academy of Sciences on May 10 and reveals a general empirical law quantifying market behavior near bubbles and crashes—these are either price lows where the share price falls before starting to rise again or price highs where the price peaks before falling.

"We asked whether or not there are regularities either just before or just after market highs and lows", says lead researcher Dr. Tobias Preis of the Swiss Federal Institute of Technology in Zurich, who specializes in analyzing and modeling financial markets. Preis is also at the Center for Polymer Studies at Boston University.

This study involved synchronizing more than 2.6 billion transactions which occurred at the European Exchange (EUREX) in Germany and at the New York Stock Exchange (NYSE) in the U.S. Preis and his fellow authors Dr. Johannes J. Schneider at the Johannes Gutenberg University Mainz and Prof. H. Eugene Stanley, also at Boston University, analyzed microtrends and macrotrends in financial markets using three fluctuating quantities: the price of each transaction, the transaction volume, and the

time between individual transactions.

"We applied our methodology to local highs and local lows in the price on very different time scales ranging from milliseconds to 100 days," says Stanley. What the researchers find is that there is a unique empirical law near bubbles and crashes, or trend changes quantifying both transaction volume and time between transactions in all the financial markets analyzed. "Even more surprising," says Preis, "we find that this empirical law with a unique parameter is valid for very small bubbles as well as for huge bubbles." In other words, the formation of bullish and bearish trends does not depend on the time scale. The well known catastrophic bubbles that occur over large time scales, such as the global financial crashes of 1929 and 2008, are not outliers. "We found the blueprint of financial trends," summarizes Preis and concludes: "We can learn from the large number of tiny bubbles how huge market bubbles emerge and burst. The challenge is to destroy bubbles before they become huge."

The importance of these findings is echoed by Dirk Helbing, professor of sociology at the Swiss Federal Institute of Technology. Helbing leads the FuturICT Flagship project, which intends to unify the best scientists in a 10-year program of the European Union to explore social life on earth and everything it relates to. "One ultimate goal of the FuturICT project is to manage challenges that make the modern world so difficult to predict, including financial crises. The discovery by Tobias Preis and his colleagues may be of crucial importance for the financial and economic crisis observatory that this flagship project will create."

More information: The blueprint of bubbles and crashes is also the subject of a feature article in the May issue of *Physics World* (Tobias Preis and H. Eugene Stanley, "Bubble trouble," Physics World 24, 29-32 2011)

"Switching processes in financial markets", Proceedings of the National Academy of Science (PNAS), Online before print version can be found at www.pnas.org/cgi/doi/10.1073/pnas.1019484108

Abstract

For an intriguing variety of switching processes in nature, the underlying complex system abruptly changes from one state to another in a highly discontinuous fashion. Financial market fluctuations are characterized by many abrupt switchings creating upward trends and downward trends, on time scales ranging from macroscopic trends persisting for hundreds of days to microscopic trends persisting for a few minutes. The question arises whether these ubiquitous switching processes have quantifiable features independent of the time horizon studied. We find striking scale-free behavior of the transaction volume after each switching. Our findings can be interpreted as being consistent with time-dependent collective behavior of financial market participants. We test the possible universality of our result by performing a parallel analysis of fluctuations in time intervals between transactions. We suggest that the well known catastrophic bubbles that occur on large time scales—such as the most recent financial crisis—may not be outliers but single dramatic representatives caused by the formation of increasing and decreasing trends on time scales varying over nine orders of magnitude from very large down to very small.

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