Predicting the unpredictable: A case study of financial market crashes

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Catastrophic events, though rare, do occur and when they occur, they have devastating effects. The study of the critical dynamics in complex systems is always interesting yet challenging. We choose financial market as an example of a complex system, and do a comparative analyses of two stock markets the S&P 500 (USA) and Nikkei 225 (JPN) based on the evolution of cross correlation structure patterns. We identify "market states" as clusters of similar correlation structures, which occur more frequently than by pure chance (randomness). Power mapping method from the random matrix theory is used to suppress the noise on correlation patterns, and an adaptation of the intra-cluster distance method is used to obtain the optimum number of market states, and also identify the "precursors" to the crashes. The dynamics of the transitions between the states are interesting. Further, the resulting "emerging spectrum" of eigenvalues near zero, have intriguing properties: (i) the shape of the emerging spectrum reflects the market instability, (ii) the smallest eigenvalue is able to statistically distinguish the nature of a market crash or crisis – internal instability or external shock. We finally investigate whether the smallest eigenvalue is able to predict a high market correlation, which is a signature of a crash.

References:

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