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Project 12.15. Fluctuations of the stock market

Although the fluctuations of the stock market are believed to be Gaussian for long time intervals. they are not Gaussian for short time intervals. The model of Cont and Bouchaud assumes that percolation clusters act as groups of traders who influence each other. The sites are occupied with probability p as usual. Each occupied site is a trader, and clusters are groups of traders (agents) who buy and sell together an amount proportional to the number s of traders in the cluster. At each time step each cluster is independently active with probability $2p_a$ and is inactive with probability $1 - 2p_a$. If a cluster is active, it buys with probability p_b and sells with probability $p_s = 1 - p_b$. In the simplest version of the model the change in the price of a stock is proportional to the difference between supply and demand, that is,

$$R = \sum_{\text{buy}} s n_s - \sum_{\text{sell}} s n_s, \tag{12.39}$$

where the constant of proportionality is taken to be one. If the probability p_a is small, at most one cluster trades at a time, and the distribution $P(R)$ of relative price changes or "returns" scales as $n_s(p)$. In contrast, for large p_a, the relative price variation is the sum of many clusters (not counting the spanning cluster), and the central limit theorem implies that $P(R)$ converges to a Gaussian for large systems (except at $p = p_c$). Confirm these statements and find the shape of $P(R)$ for $p = p_c$ and $p_a = 0.25$. Variations of the Cont-Bouchaud model can be found in the references. The application of methods of statistical physics and simulations to economics and finance is now an active area of research and is commonly known as *econophysics*.

R. Cont and J.-P. Bouchaud, "Herd behavior and aggregate fluctuations in financial markets," cond-mat/9712318.