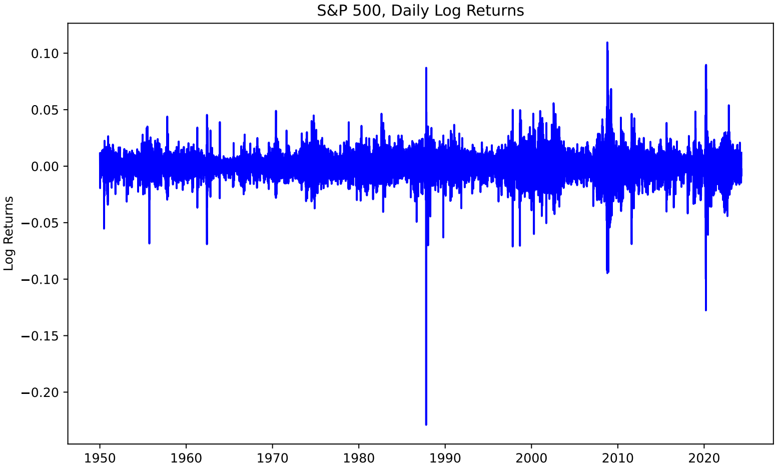
Fluctuations of the stock market

Reijo Jaakkola
reijo.jaakkola@tuni.fi

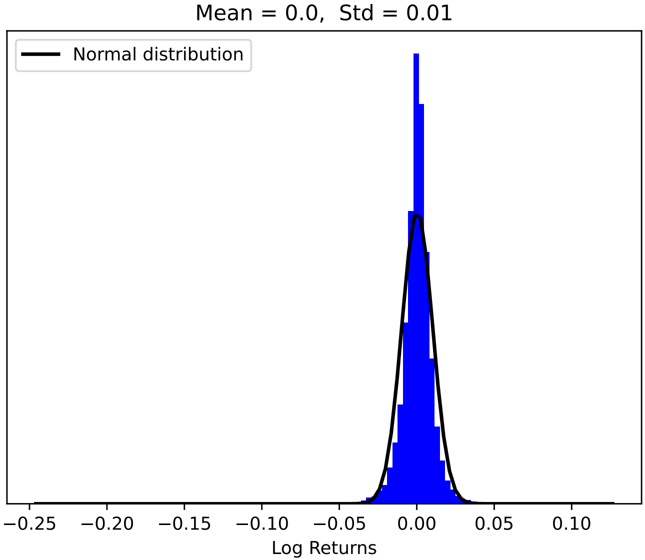
Tampere University

April 24, 2024

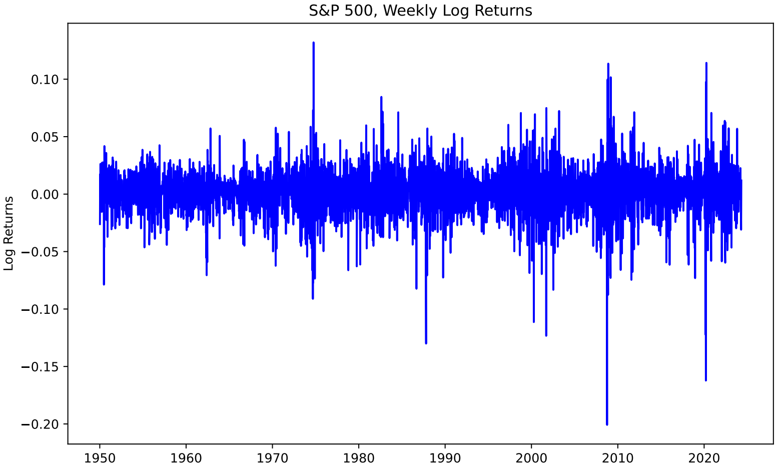
Fluctuations of the stock market



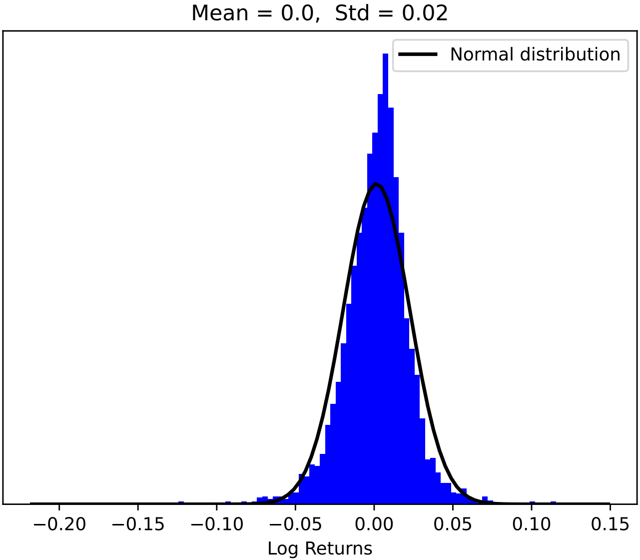
Fluctuations of the stock market



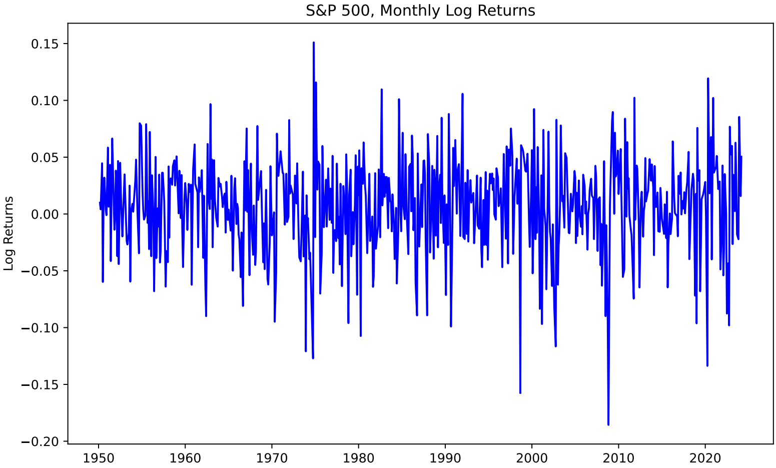
Fluctuations of the stock market



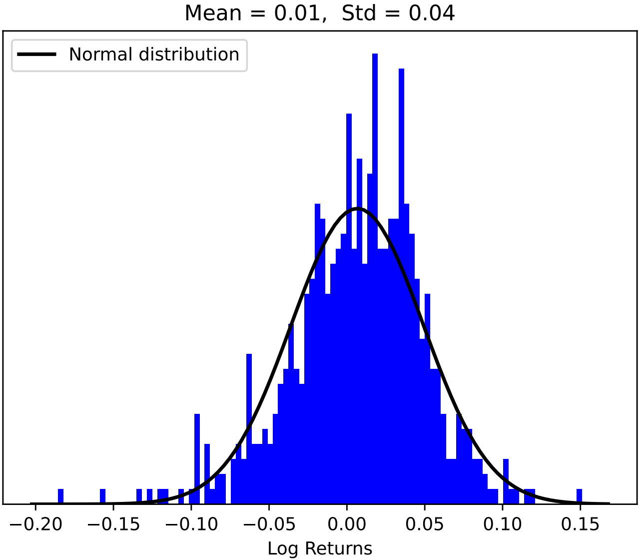
Fluctuations of the stock market



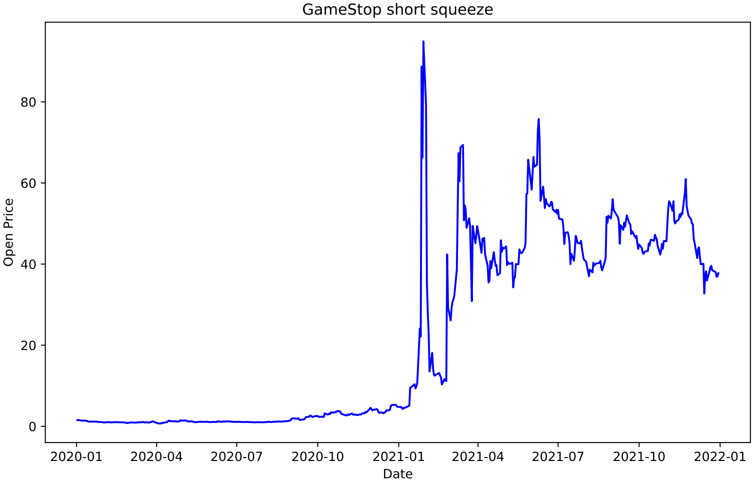
Fluctuations of the stock market



Fluctuations of the stock market



Herd behavior in the stock market



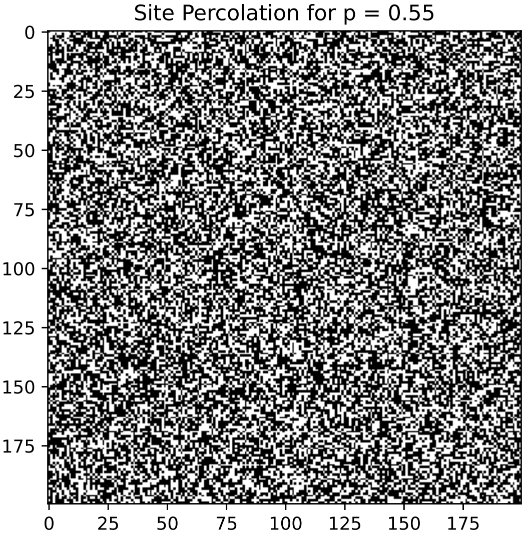
The Cont-Bouchand model for stock price changes

- Let $G = (V, E)$ be a graph. Each connected component $C \subseteq V$ is **active** with probability p_a and either **buys** with probability p_b or **sells** with probability $1 - p_b$.
- The parameter p_a can be seen as a "time-scale" parameter. Smaller (larger) p_a corresponds to smaller (larger) time-scale.
- Price change is defined as

$$R := \frac{1}{L^2}\Big(\sum_{C \text{ buys}} |C| - \sum_{C \text{ sells}} |C|\Big).$$

- In the original paper the graph G was generated by adding an edge between two nodes with probability $p \ll 1/|V|$.

Site percolation



Site percolation

- **The cluster size distribution** is defined as

$$n_s(p) = \lim_{L\to\infty} \frac{\text{average number of clusters of size } s \text{ in a grid of size } L^2}{L^2}.$$

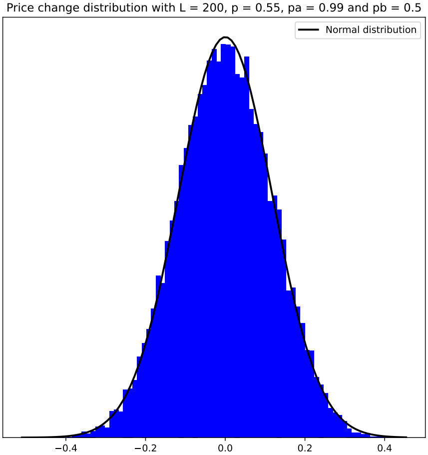
- When $p < p_c$ we have that

$$n_s(p) \sim s^{-\tau} e^{s/s_\xi} \text{ as } s \to \infty,$$

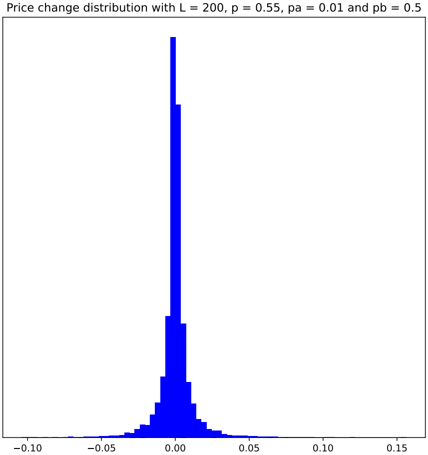
  where $s_\xi \propto |p - p_c|^{-1/\sigma}$. Here $\tau \approx 2.06$ and $\sigma \approx 0.3956$.

- $n_s(p)$ has finite variance $\Rightarrow$ for large p_a the price changes follow a normal distribution.
- $n_s(p)$ follows an exponentially truncated power law $\Rightarrow$ for small p_a the same is true for price changes.

Distribution of price changes for large p_a



Distribution of price changes for small p_a



Distribution of price changes for small p_a