Probability distribution of financial returns in a model of multiplicative Brownian motion with stochastic diffusion coefficient

ANTONIO SILVA, RICHARD PRANGE, VICTOR YAKOVENKO, University of Maryland — It is well-known that the mathematical theory of Brownian motion was first developed in the Ph. D. thesis of Louis Bachelier for the French stock market before Einstein [1]. In Ref. [2] we studied the so-called Heston model, where the stock-price dynamics is governed by multiplicative Brownian motion with stochastic diffusion coefficient. We solved the corresponding Fokker-Planck equation exactly and found an analytic formula for the time-dependent probability distribution of stock price changes (returns). The formula interpolates between the exponential (tent-shaped) distribution for short time lags and the Gaussian (parabolic) distribution for long time lags. The theoretical formula agrees very well with the actual stock-market data ranging from the Dow-Jones index [2] to individual companies [3], such as Microsoft, Intel, etc.


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