Scaling of the distribution of fluctuations of financial market indices

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Phys. Rev. E **60**, 5305 – **Published 1 November, 1999**

DOI: https://doi.org/10.1103/PhysRevE.60.5305

Abstract

We study the distribution of fluctuations of the S&P 500 index over a time scale Δt by analyzing three distinct databases. Database (i) contains approximately 1 200 000 records, sampled at 1-min intervals, for the 13-year period 1984–1996, database (ii) contains 8686 daily records for the 35-year period 1962–1996, and database (iii) contains 852 monthly records for the 71-year period 1926–1996. We compute the probability distributions of returns over a time scale Δt, where Δt varies approximately over a factor of 104—from 1 min up to more than one month. We find that the distributions for Δt<~ 4 d (1560 min) are consistent with a power-law asymptotic behavior, characterized by an exponent α≈3, well outside the stable Lévy regime 0<α<2. To test the robustness of the S&P result, we perform a parallel analysis on two other financial market indices. Database (iv) contains 3560 daily records of the NIKKEI index for the 14-year period 1984–1997, and database (v) contains 4649 daily records of the Hang-Seng index for the 18-year period 1980–1997. We find estimates of α consistent with those describing the distribution of S&P 500 daily returns. One possible reason for the scaling of distributions is the long persistence of the autocorrelation function of the volatility. For

time scales longer than (Δt)×≈4 d, our results are consistent with a slow convergence to Gaussian behavior.

References (Subscription Required)

ISSN 2470-0053 (online), 2470-0045 (print).