LONG RANGE MEMORY STOCHASTIC MODEL OF RETURN IN FINANCIAL MARKETS

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We present nonlinear stochastic differential equation (SDE) which mimics the probability density function (PDF) and power spectrum of the return in the financial markets. SDE is obtained from the analogy with previous model of trading activity in the financial markets [1,2] and generalized within the nonextensive statistical mechanics framework [3]. Proposed SDE for the normalized return $x = r/r_0$, with r_0 defining transition to the power law behavior, is as follows

$$\mathrm{d}x = \sigma^2(\eta - \frac{\lambda}{2})\frac{(1+x^2)^{\eta-1}}{((1+x^2)^{\frac{1}{2}}\epsilon+1)^2}x\mathrm{d}t + \sigma\frac{(1+x^2)^{\frac{\eta}{2}}}{(1+x^2)^{\frac{1}{2}}\epsilon+1}\mathrm{d}W. \tag{1}$$

Here the general relaxation is keyed with multiplicative noise to ensure the power-law distribution of x. The SDE with the Wiener noise W describes the diffusion of the stochastic return x restricted in some area around the zero by the relaxation dependant on the power law exponents: η, responsible for the multiplicativity, and λ, being the exponent of the power-law in the long term PDF of return x. The multiplicative noise is combined of two powers to ensure the spectral density of $|x|$ with two power law exponents. A parameter ϵ defines the crossover between two areas of x diffusion. Equation (1) models the stochastic return x with two power-law statistics, i.e., PDF and power spectral density, reproducing the empirical data of the trading return in the financial markets. In this contribution we generalize the stochastic model to reproduce statistical properties of the return observed in NYSE.

Keywords
financial markets, stochastic modeling, time series analysis, long range memory

References

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