Mark Holder
Kent State Univrsity
Ilya Tsvetkov
Nver State University

ANALYSIS OF THE DOW JONES INDUSTRIAL AVERAGE (DJIA) INDEX DYNAMICS BY FRACTAL ANALYSIS METHODS

Many experimental data possess fractal statistics. The analysis and modeling of this statistics can be performed by means of fractal analysis methods. Fractal dimension (D) is one of the prospective ways of fractal analysis. Besides, for fractal time series within the interval $t_0 < t < T$ the amplitude of the value of parameter R $R(\tau) = \max_{1 \le t \le \tau} B(t) - \min_{1 \le t \le \tau} B(t)$ depends on time t by power relation:

$$R(t) = R(t_0)\left(\frac{t}{t_0}\right)^{2-D} \quad (1)$$

(D – fractal dimension of the time series).

Using this equation and knowing the fractal dimension of the time series on the starting basic segment, one can predict the possible future value of the amplitude of the parameter in question.

In the approach under study, the presence of the critical value of the fractal dimension of the time curve $D_0 = 1.6$. Near this value the system loses its stability and its parameters may either increase or decrease, depending on the trend of the time in question.

Besides, the value of the fractal dimension may serve as an indicator of the number of factors influencing the system. By the fractal dimension less than 1.4, the system is influenced by one or several powers, that generally move the system in one direction. If the fractal dimension value is about 1.5, then the powers that influence the system are differently directed, but they compensate each other more or less. The system’s behavior in this case s stochastic and is well described by classic statistical methods. If the fractal dimension is much more than 1.6, then the system becomes unstable and is ready to shift into the new state.

The daily dynamics of the DJIA index with the refresh rate of 20-30 seconds within the period of several weeks have been studied. The fractal dimension of the dynamics varied to a rather great extend from the value of 1 up to the values that indicate some instability that may occur on the Stock

Exchange markets. After such moments the index usually fluctuated drastically.

The prediction of local trends made by means of the following equation proved the fractal methods application for the description of DJIA index dynamics:

$$\bar{y}(t) = \bar{y}(t_0) + \frac{K_f(t_0)(t - t_0)}{(D - D_0)^{\beta}} \quad (2)$$

($y(t_0)$ – the average value for the pre-predicted period; K_f and β - coefficients; t_0 – the period of time before the unknown period under study; t – the time period for which the forecast is made).

Analyzing the fractal dynamics during one day, we can say that the given time series is multifractal by its nature. That means that its fractal dimension changes greatly with time. But taking into account the scale, one can find the segments with constant fractal dimension. They are influenced by more or less the same factors.

One can identify rather stable segments with rather high fractal dimension values, and the areas of transition between them with the jump-like index fluctuations. The stable segment was from period of 15 minutes to several hours. And the value of the next fluctuation depends to a great extend on the fractal dimension of the time series on a rather smooth last segment. The correlation coefficient between them was 0.35 by several days, which indicates the link between the fractal dimension on a relatively smooth segment and the value of the next fluctuation. But this rule proves correct only for the days when the fractal dimension of the index time series didn’t go beyond the value of 1.45. On less stable days other more complicated laws work.