ELLIOTT WAVES IN NONLINEAR DYNAMIC ECONOMICAL SYSTEMS

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A comprehensive analysis of the world economy, looking at its past, present and future development and performed by eminent researchers, proves that it is a self – organizing nonlinear dynamical system. It is revealed that currency and stock markets are the real regulator of the sustainable development of the world economy. The most effective regulator of the synergetic nature of the world economy is the system of stock markets, which ensure systematic investment of finance in all branches of the modern economy.

The processes of investing financial resources in the world economy for the purposes of particular countries or their regions are multidimensional random processes $\xi(t) = (\xi_1(t),\ldots,\xi_n(t))$. Each component of $\xi_i(t)$ in $\xi(t)$ in its turn is a multidimensional random process $\xi_i(t) = g_i(\xi_{i1}(t),\ldots,\xi_{im}(t),\ldots)$ of different dimension. In all cases of observation of a particular random process of securities quotation formation there is no possibility to construct mathematical stochastic model of random vector $\xi(t)$ and its individual components. In real life stock market processes are registered with application of modern computer information technologies that allow calculating of different parameters such as stock, option and other securities prices at the opening and closing of the stock exchange and the number of their realizations. The dynamics of price fluctuations are represented by time series in which time can be recorded with high accuracy (up to a millionth of a second). Time series are registered for all bidders in the markets. The time series $X(t_1),\ldots,X(t_n),\ldots$ for each company is essentially a statistical model of the random process $\xi(t)$.

Main mathematical tools for the study of dynamic self-organizing nonlinear processes of stock markets include analysis, processing and forecasting of dynamic processes for all market participants on the basis of the time series. Let's consider some mathematical features of each one-dimensional time series. It is proved that the dynamics of price fluctuations is cyclical [1]. The study of the structure of cycles of price fluctuations is an important and very complex problem of statistical analysis of time series [3].

It is established that a one-dimensional time series of quotations of stock and options on the stock markets $X(t)$ is a mixture of at least three random processes. The term "mixture" emphasizes that the components of the mixture in general are not independent random variables, but the relationship between them is non-linear in nature and they can be uncorrelated at individual time intervals where the nonlinear dependence has a meaningful meaning.

Three emphasized components $X(t)$ are associated with three random processes with different development mechanisms. Computer analysis of the of stock price time series allows to establish that the dynamics of the development of time series is determined to a large extent by the following factors:

– Economic fluctuations of a chaotic deterministic nature are caused by regularly occurring fixed points that can asymptotically approach the general limit [6];

– Fluctuations of $X(t)$ have the nature of random processes with independent increments due to a huge number of market participants with ever-changing interests in the purchase and sale of securities [2];

– The structure of wave oscillations are due to the constantly acting process of Elliott wave generation in which the trend of fluctuations always consists of five fluctuations in growth associated with an increase in price and three fluctuations in the decrease caused by the opposite actions associated with corrective actions.

In the first case, at any time t_i the time series $X(t_i)$ has a form that is congruent to the logistic equation $X(t_{n+1}) = aX(t_n)(1 - X(t_n))$ that has following graphical representation.

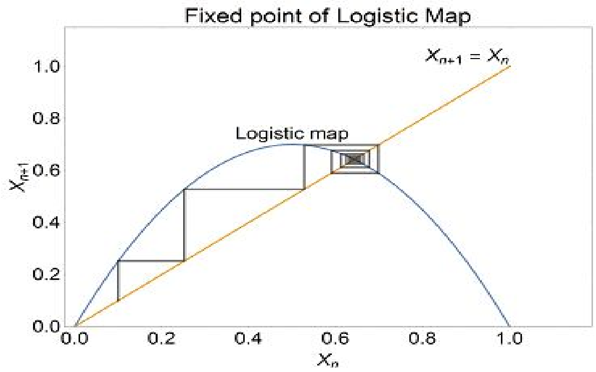

Figure 1. Logistic map

This process describes the acquisition of shares in the interval (t_n, t_{n+1}), which leads to the exhaustion to a certain extent of this resource by the time t_{n+k} (this may be the end of the trading day). As it is proposed in work [6] the chaotic character of the logistic map is proved to conjugate to tent map which allows us to consider the dynamic nature of the processes in more detail and investigate iterative fixed point formation process [7,8].

In the second case, based on the fact that a continuous stream of orders on the stock exchange contains unrelated orders, a model of Geometric Brownian Motion can be used for a simplified description of the process of purchase and sales. This approach to stock markets was first proposed by M. F. M. Osborne [5]). This model, unlike the Brownian motion, is everywhere positive and has a log-normal price distribution law. Figure 2 shows representation of Brownian motion trajectory for a participle on 2D plane and simulation of a geometric Brownian motion process. Processes of this kind cause constant fluctuations during one trading day.

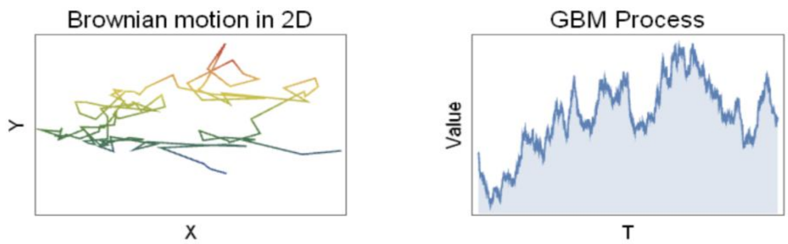

Figure 2. Brownian motion simulation

However, it follows from randomness that it is impossible to predict the growth or fall of any particular stock, but by virtue of the law of large numbers, one can obtain information about the behavior of markets in the long-term perspective.

In the third case, the fundamental law of nature [4] can be observed according to which the development of the price of any share (option) consists of five fluctuations with growth and decrease of its values, but are close to a certain value and with the subsequent three steps of adjusting the price of a financial instrument. Graphical representation of the process is shown on figure 3:

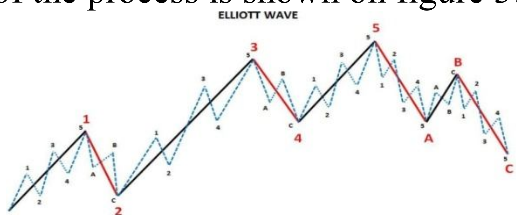

Figure 3. Elliott wave structure

The number of waves of development can be more than five, but the number of correction waves is always less number.

Construction of the mathematical theory of Elliot waves is associated with the development of mathematical methods for modeling decision-making processes by people in a socially-dynamic environment. Analysis of decision-making processes by people (brokers) in the stock markets confirms that the desire to sell a financial asset at higher price, always requires more fluctuating decisions than making decisions related to price adjustment at some acceptable level. This is due to the cognitive activity of a person (people), which is confirmed by the results of works on which the Nobel Prize in economics was awarded this year.

The structure of Elliott waves is congruent to the lengths of individual waves at the development stage and at the correction stage. It is established that the number of waves of the development stage is always greater than the number of waves at the stage of correction. This is due to the fact that the adjustment phase is always associated with minimizing financial losses and maximizing the possible profit margin.

Analysis of the observed Elliott waves confirms the point of view that these waves are the result of the collective intellectual activity of a large number of people with an agreed strategy for achieving success, and also confirm the Keynes business cycle model [2].

It is proved that the use of Elliott waves, the theory of fixed iterative points and random walk processes creates the basis for stabilizing and improving the efficiency of stock markets as a regulator by the processes of investing financial assets in the developing world economy.

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