DOI: 10.33278/SAE-2018.eng.153-157

JEL C51

THE MODEL OF THE STOCK MARKET AND THE TYPES OF RESONANCE EFFECTS ON ITS INDICATORS

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Abstract. In this paper, the stock market model is considered as an oscillatory system with eigen frequencies determined on The basis of the Elliott wave principle, which can be included in various types of resonant interaction with the outside world. An example of stochastic resonance of RTS index under the influence of information «white noise» is given.

Keywords: stock market, Elliott wave principle, stochastic resonance, resonance phenomenon.

Against the background of globalization and increasing competition of the economies of the world's growing risks and increasing instability in the global economic space. Virtual financial capital, stock and currency markets, whose behavior depends on information signals coming from the outside or originating inside them, have an increasing impact on the economy. These information signals are the final link in the chain of events of the outside world and changes in the mass consciousness of financial market participants (Fig. 1).

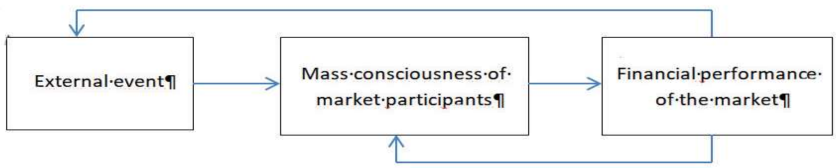

Fig. 1 Scheme of interaction of events of the outside world, mass consciousness of market participants and financial indicators

An example of the impact of natural factors on the stock markets is the relationship of the moon cycles and financial results of market participants. According to a study by Macquarie Securities specialists [1], stock markets, in fact, are hypersensitive barometers, responsive to the invisible influence of the moon cycles on the psychological state of people. Macquarie cites two academic studies in which it was found that net profit in the stock market with the moon rising almost twice higher than similar indicators in the period of the full moon. In addition to this example, there are also many other cyclic processes in nature, the cumulative effect of which can not be ignored in the analysis of the dynamics of financial markets, for example, cyclical processes in the economy [2].

Cyclical changes in the mass consciousness of market participants lead, according to R. Elliott [3, 4], to the wave nature of market movements. Elliot considered his concept of the securities market as part of a much larger whole - namely, the universal law of nature that governs all spheres of human life.

Close to the views of Eliot can be considered and Tesla ideas about the nature of the interaction of processes in nature, which he considered wave, and as a universal mechanism of their interaction called resonance [5]. Tesla believed resonance to be the key to understanding and managing any system, natural or man-made. Each system, in his opinion, has a certain "natural oscillation frequency". Such frequencies can be several; they are a kind of "passport", "identity card" of any system. Any systems can interact, being tuned, on each other.

Considering the stock market as a large system, we will also assume that it has a set of natural oscillation frequencies or wavelengths, between which there are unambiguous matches. R. Elliot in his book "the Law of nature: the secret of the universe" wrote that the frequencies of these waves correspond to the Fibonacci numbers. All market cycles consist of two types of waves: driving and corrective. The first are signed with numbers from 1 to 5, and the second are marked with Latin letters A, B, C, see table. 1.

Table 1

The ratio of the wavelengths

Elliott wave	The ratio of the lengths of waves according to Fibonacci
1	Reference wave of any length
2	0.382, 0.5 or 0,618 the wavelength 1
3	1.618 or 2.618 the wavelength 1
4	0.382 or 0.5 the wavelength 1
5	0.382, 0.5 or 0.618 the wavelength 1 (or equal to a wavelength of 2)
A	0.382, 0.5 or 0.618 the wavelength 1 (or equal to a wavelength of 5)
B	0.382 or 0.5 the wavelength A
C	1.618, 0.618 or 0.5 the wavelength A

Table 1 shows the ratio of these wavelengths to the reference wavelength, which is selected on the basis of the simulation method in such a way as to best smooth the initial time series, which is the dynamics of the price of a financial instrument (Fig. 2). The time series is presented in the form of Fourier series expansion:

$$m(t) = a_0 + a_{01}t + \sum_{i=1}^{r}(a_i \cos\omega_i t + b_i \sin\omega_i t)$$

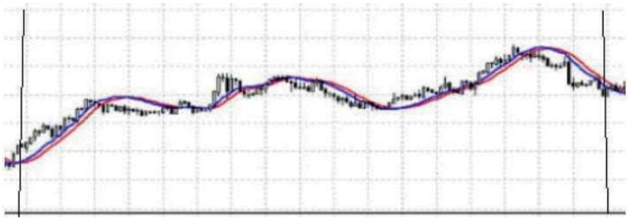

Fig. 2 Charts of the financial instrument price (initial and smoothed with the help of harmonics)

Thus, it seems appropriate to present the dynamics of financial market indicators as a result of the influence of stochastic oscillatory processes on the system with its own frequency characteristics corresponding to the Fibonacci numbers.

The most important consequence of the wave nature of the dynamics of financial market indicators is the possibility of such interaction of waves of different nature affecting them, which has the most effective impact on their change based on resonance. Detection of resonance phenomena in the financial markets, understanding their nature, will allow to predict the dynamics of financial indicators and, using various mechanisms of influence on the financial markets, to avoid the onset of the crisis.

The financial market is a nonlinear oscillatory system. However, with small amplitudes of fluctuations of financial indicators (with small deviations from the equilibrium position), financial markets can be considered linear, fluctuations in them are described by linear differential equations, which allows using the General theory of fluctuations. If it is impossible to consider the financial market as a linear system (large deviations from the equilibrium position), the system's own oscillations will no longer be harmonic, and their frequencies will depend on the amplitude of the oscillations. The dynamics of financial indicators should be described by nonlinear equations. For nonlinear systems, unlike linear systems, the principle of superposition is violated, according to which the resulting effect of a complex process of action is the sum of the effects caused by each action separately, provided that the latter do not affect each other.

In such a nonlinear system the resonance will be characterized in that during the buildup of financial indicator external force (impact on financial market participants) the difference between the frequency of the driving and the financial market (? - ?0) will change as the frequency ?0 will depend on the amplitude of oscillation.

An example of a nonlinear oscillatory system are self-oscillating systems, which belong to the group of nonlinear oscillatory systems. They compensate for dissipative losses due to the inflow of energy from an external constant source. In this case, the system itself regulates the supply of energy to the system, feeding it at the right time and in the right amount. The presence of market regulators allows us to consider the stock market as a self-oscillating system.

The impact of regulators on the market with a certain frequency, close to the natural frequency of the market, allow to ensure its stable equilibrium operation. The advantage of using resonance phenomena is their efficiency and large oscillation amplitude. The disadvantage is the instability of the system, associated with the necessity with a high degree of accuracy to maintain the resonance condition (? - ?p), since any deviation of the frequency of the external effects of resonant frequencies in the narrow resonance curve sharply change the amplitude of the oscillations in the system.

We will consider the financial market as a linear distributed oscillatory system, which behaves as a set of independent harmonic oscillators. In linear distributed systems, there is an infinite but countable set of normal oscillations (Eigen frequencies of oscillators). Considering the stock market as a single oscillatory system, and interacting with it an external system consisting of market participants, which are affected by economic and natural factors, we get related systems. Vibrations arising in coupled systems are called coupled oscillations.

Fluctuations in one system due to the presence of the connection cause fluctuations in the other, i.e. there is a transition of energy from one system to another. With external excitation of the system, normal oscillations largely determine its resonance properties. Resonance can occur only when the frequency of the harmonic external action is close to one of the natural frequencies of the system, or to their linear combination, if the external action changes the parameters of the system (parametric resonance). In the linear approximation, the natural oscillations of these systems are a set of normal oscillations (modes). If the response of the system is the total response of all degrees of freedom, then the resonance curve will be the superposition of the resonance curves of individual normal oscillations and can be complex.

Thus, in a system with two degrees of freedom, due to the fact that the natural oscillations can occur with two different frequencies, the resonance occurs when the frequency of the harmonic external action coincides with both one and the other normal frequency of the system. The selection of the parameters of normal fluctuations can create a resonant curve of any shape that can be used when choosing a mechanism of influence on the stock market.

One of the mechanisms of influence on the oscillatory system (stock market) is stochastic resonance [6]. Stochastic resonance is a phenomenon of amplification of a periodic signal under the action of white noise of a certain power, inherent in many nonlinear systems, which are under the external influence of both chaotic and weak periodic action. The phenomenon of stochastic resonance is due to the nature of white noise, the spectral components of which are evenly distributed over the entire range of frequencies involved. In this case, the frequencies coinciding with the frequency of the weak periodic signal cause a resonance effect (amplify the periodic signal). Amplification of other components of white noise does not occur.

The role of stochastic resonance in the dynamics of financial markets has not been studied, although, on the basis of General considerations, it may be responsible for a significant contribution to the change of its parameters, including "bubbles" and crisis phenomena.

The hypothesis of stochastic resonance was tested in [8] as an explanation of changes in monthly levels of the RTS index. Logarithmic returns of Brent oil prices, the time period from may 2003 to may 2007 are used as an information signal, as can be seen from the table. 2 the RTS index is weakly correlated with the logarithmic returns of Brent oil prices, which suggests that the latter can be taken as a sub-threshold signal.

Table 2

Values of correlation coefficients between logarithmic returns of Brent prices, as well as logarithmic returns of RTS index and "modified differences" of RTS index for the analyzed period

The period	ρ (yields RTSI and Brent)	ρ ("modified difference" and RTSI yield Brent)ρ
May 2003-March 2007	0,1924	-0,0936
May 2003-March 2005	0,0519	-0,1387
April 2005-May 2007	0,2319	0,1818

The periodic component of the information signal was selected using the Statistica package (Fig. 3). The corresponding circular frequency ω=1,8325.

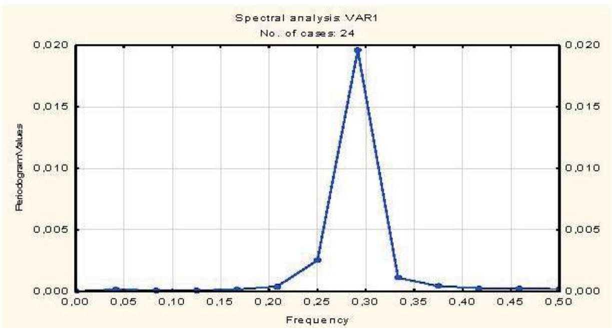

Fig. 3 The frequency characteristic of the signal

Deviations of the real subthreshold information signal (logarithmic yield of oil prices) from its periodic component. it is a Gaussian noise. Based on historical data, the noise intensity D=0.0072 was obtained. The method of simulation was used to search for the optimal value of the noise intensity. It was found that the maximum signal-to-noise ratio is reached at Dopt=0.1311. In addition, an increase in the noise intensity can transfer the system from one stable equilibrium position to another, which suggests the presence of stochastic resonance.

SUMMARY

1. The stock market model in the form of a set of oscillatory processes with the distribution of natural frequencies corresponding to the distribution of Fibonacci numbers adequately reflects the dynamics of its financial characteristics.
2. The presence of various types of resonant impact on the stock market, including parametric and stochastic, sets the task of identifying effective mechanisms to maintain its financial stability and efficiency of investments in financial instruments.
3. Simulation modeling has shown that when the amplitude of the harmonic of the information signal increases at some level, there is a sharp increase in the level (amplitude) of the corresponding harmonic of the financial indicator, which implies the presence of stochastic resonance.

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