

## PARAMETRIC SPECTRAL ANALYSIS PROCESS OF TIME SERIES FLUCTUATION STOCK MARKET PRICES

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**Abstract:** To describe a problem of a parametric spectral analyze of a time series fluctuation price process on a stock market. It is used difference-linear equation like the model of the initial data. It's has been obtained stable results of estimation parameters by stochastic smoothing. **Keywords:** ARMA, spectral analyze, time series fluctuation price.

### 1. INTRODUCTION

It is necessary to spend careful, statistical data processing to maintenance of exact forecasting of behavior of the prices in a stock market. Some form of price cycle, alternating periods of growth and fall of the prices is inherent in the market, presence of the appropriate hierarchy of cycles enclosed each other in such a manner that inside movement of the greater amplitude and duration there are faster movements with smaller scope. One of the most urgent research problems of the stock market - is revealing laws and periodicity of fluctuations of the prices in the market. However there are some problems complicating to make it:

1 It is impossible to construct adequate dynamic model of the market in view of influence of all external parameters both connections (linear and nonlinear), all factors displaying interaction and parameters of global economy. Mutual influence and the huge quantities of these factors and complexity of their interaction do not allow to isolate and to study separate components of market model;

2 If to assume, that the model, interesting for us, exists and is accessible to the analyst, all the same nonlinear properties of model will cause its highest sensitivity both under the attitude to the entry conditions, and to accuracy of an estimation of parameters of economic development influencing behavior of the market.

The marked problems are aggravated also by highest role of mass psychology in formation of the market prices mechanism, when the same objective fact can result in opposite movements of the market only because of a difference in its perception by the subjects of market environment.

Therefore, decisions of the above specified problems necessary diagnostics of the market condition and the future changes of investment qualities of valuable papers forecasting through the spectral analysis executed based on the researching of time series data of the money intelligence for the last intervals of time. Now, the classical methods are applied as methods of the spectral analysis [1]. However digital algorithms developed based on the classical methods of the spectral analysis, not always allow to receive qualitative results of processing of the initial data,

especially if the time of the analysis is limited [2]. Besides at the insufficient size of estimated data typical situation at the analysis of the share quotations the received estimations, through the given methods, can differ from real values.

Therefore, application high - requiring to resources, information and technical, the classical methods not always allow to make exact forecasting, and done not apply at all for the analysis of the share quotations in a mode of real time, in view of high changes dynamic in the exchange market.

In view of above stated, development of new methods of the analysis of the time series of the price changes, and their integration in modern technological products, which would be capable to ensure relative reliability of results, at a small enough set of the entrance data - is a urgent task.

### 2. MATHEMATICAL BASIS OF THE METHOD

One of the most perspective directions of increase of the digital spectral analysis efficiency is parametrical estimation of the time series of fluctuations of the prices. In this case task of the spectral analysis is reduced to a choice of suitable model of an observable the time series and estimation of its free parameters [2].

Now as model of an experimentally observable time series  $x_n$  use difference-linear equation with constant  $a_k$   $b_k$  factors and following kind more often:

$$x_n = \sum_{k=0}^q b_k u_{n-k} - \sum_{k=1}^p a_k x_{n-k}, \quad (1)$$

where  $q \leq p$  and  $u_n$  - some stimulating sequence, which a priori gets out proceeding from character of a soluble task.

It's accepted, that the sequence  $u_n$  is white noise with zero average value and unit dispersion  $\sigma_u^2 = 1$ , in most cases [2].

Let's enter the following designations

$$c_k = \begin{cases} a_0 = 1, & k = 0; \\ a_k, & 1 \leq k \leq p; \\ b_{k-p-1}, & p+1 \leq k \leq q+p+1. \end{cases} \quad (2)$$

$$y_{n,k} = \begin{cases} x_{n-k}, & 0 \leq k \leq p; \\ u_{n-k+p+1}, & p+1 \leq k \leq q+p+1. \end{cases} \quad (3)$$

In result it is received difference-linear equation with unknown constant factors  $k c$

$$y_{n,0} = \sum_{k=1}^{q+p+1} c_k y_{n,k}. \quad (4)$$

The definition of factors  $c_k$  results in necessity of the decision of system of the equations where  $c_0 = 1$  and  $n \in [p, 2p+q]$

The number of the equations of system (5) is minimal and is equal to number of unknown parameters  $a_k$  and  $b_k$  initial difference-linear equation (1). Therefore at its decision we shall have the increased sensitivity of estimations of these parameters to the time series  $x_n$  and stimulating sequence  $u_n$ .

To receive steady results estimation of required parameters  $a_k$  and  $b_k$  it is possible at the expense of their statistical smoothing. However for this purpose it is necessary to have additional a priori the information concerning the time series  $x_n$  subjected the spectral analysis. It is known, less than ten recurrences of a cycle are necessary no, that it was possible to check up statistical reliability of a cycle [1]. Actually it results in increase of number of the equations in system (5), that is the number of the equations will be more number of unknown parameters  $a_k$  and  $b_k$ . Such approach in the statistical theory parametrical estimation is known and gives the results converging to the exact decisions [2].

On p Fig. 1. the brief record of the circuit of algorithm of simultaneous calculation of parameters and linear difference of model is given which reflects as separate stages a sequence of a course of the decision of the redefined system of the equations (4).

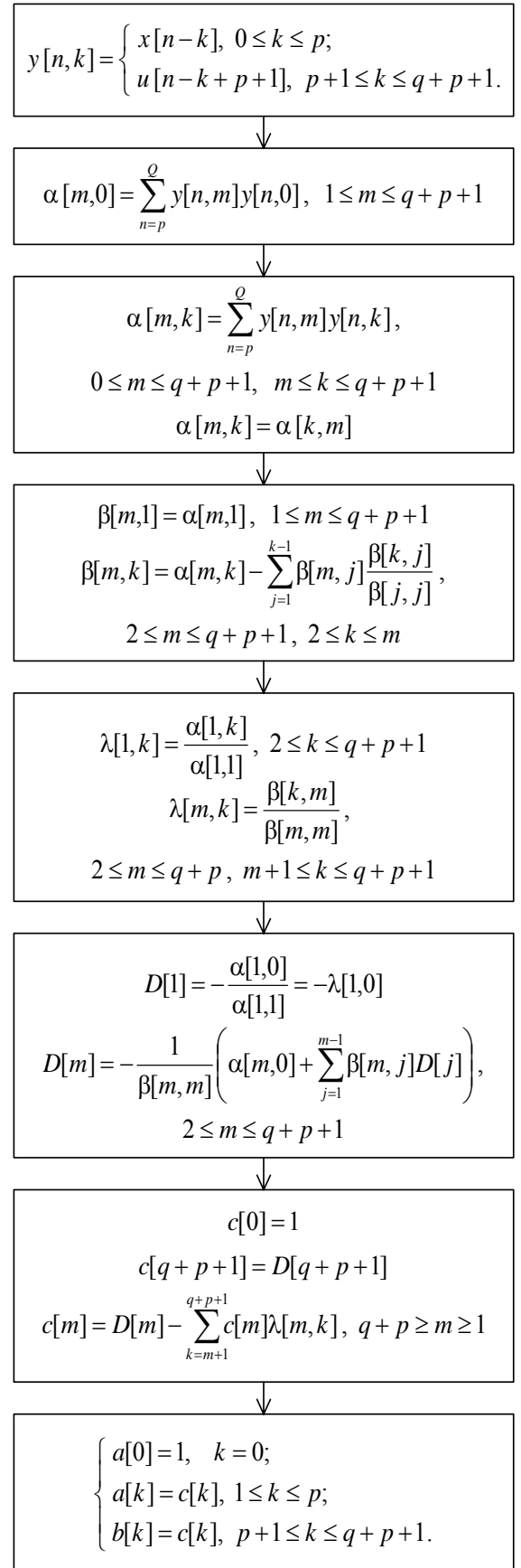


Fig 1. The circuit of estimation algorithm of parameters linear difference of model of a temporary line

### 3. APPLICATION THEARMA METHOD FOR RESEARCHING OF THE STOCK QUOTATIONS

For research of the time series of the prices fluctuations of on share, futures or currency stock exchange the special software was developed which allows easily enough and precisely to make estimation of researched process.

As an example for demonstration of work developed software, the day time diagram of the prices for last 6 years, largest Russian company is shown, the changes of which prices differ high dynamic, without essential anomalies in behavior (Fig 2).

In a fig. 3 the normalized estimation of spectral density of capacity is submitted.

The high values of the prices tend to accumulate near to some frequencies. The situation of peaks in each of such areas of a congestion of high values shows possible cycles. On the offered diagram as possible cycles such 4 relative peaks are shown.

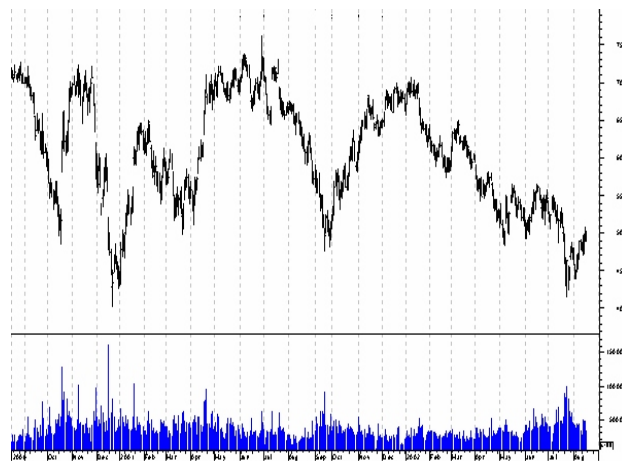


Fig 2. The day time diagram of the prices for 3 years of the Unified Energy System of Russia  
Source: products of CQG

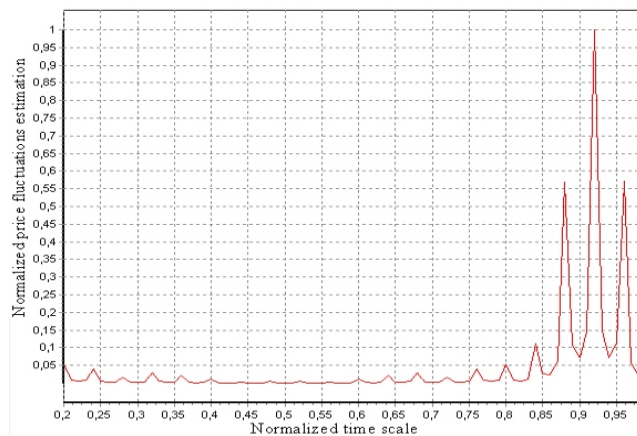


Fig 3. Normalized price fluctuations estimation of the day time prices for 3 years of the Unified Energy System of Russia

### 5. Development of information maintenance on a basis ARMA method

In this connection technical information systems the using various methods of the analysis and data processing of the share quotations now develop..

In connection with the high standards of development of information systems, the rigid requirements to the automated information systems (AIS) are showed. It is necessary list functionalities which should in itself to have modern AIS:

- means of the tax of the primary information from gauges and devices of the bottom level;
- means of a storage of the information with primary and subsequent processing;
- means of display of the information in a convenient format (as the summary reports, diagrams and. etc);
- opportunity of work of system both as the local version, and in structure of uniform global system.

Basis of the majority AIS can include and some applied programs such as: control systems of databases (CSD), interfaces and protocols of connection low, hardware, level with software and etc.

Besides performance of the designed functional maintenance the system should guarantee equally reliable work on various hardware and system platforms. The independence of a platform is given to the developer AIS distributed the Client - Server systems, about use Web - sphere. The advantages of such systems are obvious:

- the choice CSD does not depend on the established operational system (OS), and always can settle down independently under the relation to Web server;
- the choice OS depends on technology which is used for designing server part of AIS;
- the client part is completely independent from OS, and the presence Web-bruizer demands only;
- the multiuser access to AIS with a rigid regulation of the rights, and conducting a history of an entrance is possible;
- independence of hardware maintenance, as all management incurs OS and standard interfaces.

In view of above stated the component ensuring interrelation AIS with various CSD is developed. Use of the unified technologies of access to the data, such as OleDb, is not optimum and expensive from the point of view of productivity. A component the inheriting uniform interface, but realizing methods of access to the data for everyone CSD separately therefore was developed.

The diagram of a class of this component submitted in figure 4



Fig 4. The diagram of classes components Data Access for projected AIS.

In given a component all necessary methods for work with a database (DB) such as are realized:

- reception such as CSD;
- reception connection and transaction;
- call and performance of stored procedures, functions with parameters and without;
- performance SQL of inquiries;
- distribution both management of roles and rights of the users.

At realization of such approach of designing terms of development by all AIS as a whole, and consequently also

economy of material resources are reduced. Further, if necessary to use new CSD, it is enough only to realize standard methods of classes. In given AIS the methods of work with the data for most popular CSD for today are realized: Microsoft SQL Server, Oracle, PostgreSQL, MySQL. The given choice caused by that the user chooses CSD from preferred OS and possible loading on AIS.

However use only of one method of the spectral analysis is extremely not effective. The application of classical methods is expensive in relation to computing and information resources, use ARMA and other methods parametrical spectral estimation not always allow to construct an exact picture of casual processes. Therefore for

achievement of a peak efficiency of work AIS, was decided to combine the various approaches spectral estimation. Component is constructed by the same principle, as DataAccess (Fig 5).

In submitted a component three methods spectral estimation are reflected: ARMA, harmonically and classical, based on direct transformation Furier.

Applying the mixed techniques spectral estimation to become possible to use the positive parties everyone:

- use of a classical method allow to receive the exact spectral characteristic, thus there is no loading on the client and network, as all operations carry out on cepvepe;

- application of parametrical methods, in a particular ARMA, will allow to receive operative estimations.

In addition to above told, at use of such architecture of construction of system to become possible to add new and to change available estimation methods not mentioning business logic of system. Such approach allows to save material means for completion, modernization of methods, message of development of new algorithms spectral estimation by the third persons irrespective of the basic developers AIS

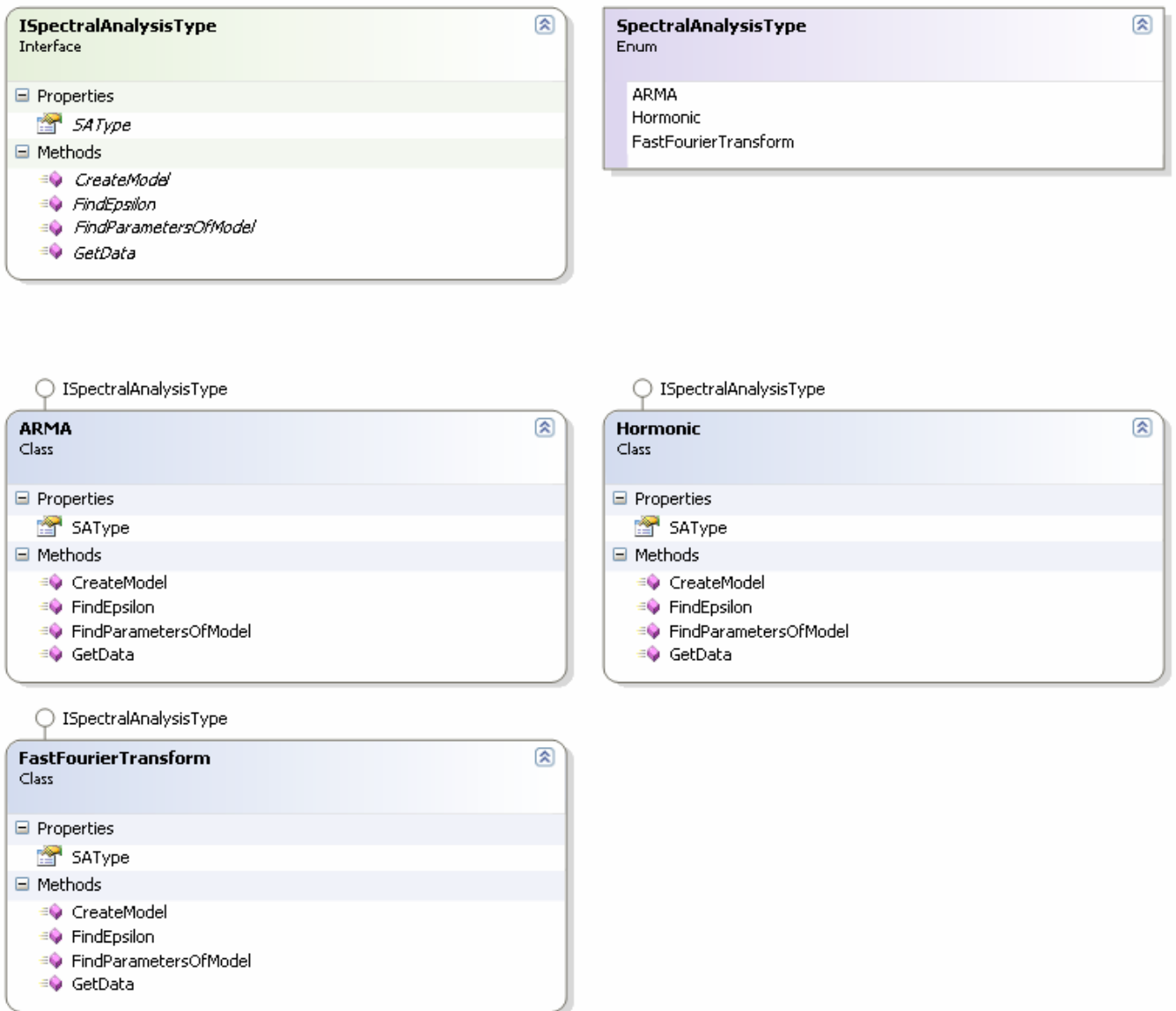


Fig 5. The diagram of classes for components spectral estimation

### 3. CONCLUSION

Thus, the description of a method of spectral analysis for research of changes of the prices in the share market is given in the paper. Let's note, that the given method allows to lead operative diagnostics of the current condition of the share market on the time series given to the money intelligence. Thus, methods of the spectral analysis of researched market processes with the help ARMA method is an effective means of the analysis of the market of valuable papers.

### ACKNOWLEDGMENTS

Thank you CQG for given information sock market information.

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