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STOCK MARKET STATISTICAL DATA ANALYSIS FOR PRICES FORECASTING AND TRADING DECISION SUPPORT

Abstract. *A general problems and methods for stock market statistical analysis are analyzed. A new method for stock price forecasting problem is considered based on a time series structural decomposition approach realized in special assignment of wave component auto-regression model as a superposition of harmonics with tuning frequencies. Computer simulation has been fulfilled in order to evaluate the performance of proposed method and algorithms.*
Keywords. *Auto-regression model, forecasting, statistical analysis, stock market, structural decomposition, time series.*

The main activities on the stock market, namely portfolio selection, investment and trading are widely using different mathematical methods in order to improve the decision effectiveness under uncertain conditions. The classical portfolio theory use the stock returns statistical parameters estimates like means and covariance, but the practical applications of such a methods come into collision with a great difficulties caused by the large number of stock parameters and market indexes under consideration. Financial analyst faces the challenge of huge amount of data analysis. Consequently the practicable methods should to include the facilities for stock market model parameters number reduction in order to make easy the market situation estimation and decision-making.

In such a way, the most perspective methods of stock market statistical analysis may be divided into three groups [1].

–*Stock market cluster analysis*, which ensure separation of companies into the groups of companies with similar statistical properties such as mean prices, standard

deviation, variability and oscillation, brandish, great deviation probability ets. The cluster recognition picks out the groups of companies, which are more preferable for different market activities such as investment and trading.

– *Stock market factor analysis*, which enable to discover the considerable small number of generalized parameters (factors) and ensure most informative factors determination and recovering, which represent the main properties of analyzed companies, stock market data aggregation, stock parameters reduction with the simplification purpose of stock return model and data compression.

– *Stock market regression analysis* for the purpose of dependence estimations between different market factors and returns statistics. Stock market multivariable regression analysis ensure statistical interrelations determination between different stocks factors and market indexes, stocks return model identification and verification**.**

There are many approaches for such a problem presented in scientific literature, but it practical applications may realizes only by means of special software for statistical analysis of stock market for the purpose of market analysis facilitation, decision-making support and recommendation elaboration for investment and trading. In conjunction with the visual facilities for data representation and user's intellectual interfaces, the software realized the above methods might be very useful instrument for stock market analyst and may be used in decision-making support information system produced the recommendation elaboration and optimization.

Besides the classical statistical approaches, the modern techniques of artificial intelligence for data analysis such as artificial neural networks, genetic algorithms and fuzzy systems as well as data mining technology (knowledge recovering from data) find now a different application in stock market statistical analysis [2].

The special software is needed for latent features and factors extraction and recovering, which are most informative for stock prices analysis and forecasting.

One of the most important problem of stock market statistical analysis is stock prices forecasting and buy/sell decision support. The efficiency and

accuracy of forecasting essentially depends from the adequacy of time series model. The popular forecasting methods usually use the simple models like "trend + noise" or ARMA models in combination with suitable parameters identification algorithms [3]. However, in practice, real stock price time series have a more complex structure, such as non-periodic oscillating time series. Such a functions, so calls wave time series, may be sufficiently used as mathematical models of financial time series.

Many samples of stock prices have a wave (non-periodic oscillating) structure so can be represent as a combination of the number of harmonics with unknown and changing frequencies and amplitudes.

A new approach for stock prices wave time series forecasting is based on the idea of harmonic structure analysis of time series and uses a special assignment of wave component auto-regression model as a superposition of harmonics with tuning frequencies [4, 5]. In such a case, the suitable identification algorithm also ensures non-stationary frequencies tracking.

The proposed method, based on the structural modeling approach, is seemed to be very useful for seasonal and oscillating economic and financial time series.

The method of stock price harmonic analysis and forecast ensures:

– Model selection (i.e. determination of number of essential harmonics and its parameters).

– Model updating (real-time estimation of amplitudes and frequencies).

– Short-term forecast of stock prices and decision function construction in order to obtain the buy/sell decision recommendation.

The peculiarities of the method are the initial time-series decomposition on the slow (trend) and fast (oscillatory) components with the help of digital filters. The special adaptive technique [4, 5] is used for model updating with the combination of detection of days when the prices time series change its properties. The proposed procedure of data processing and trading decision support includes:

– Stock prices database scanning in order to select the companies suitable for forecast and trading (time series with expressive oscillatory structures and desirable overage prices).

– Identification of harmonic models for every companies from the selected set of “perspective” companies using accumulated data (amplitudes and frequencies as well as necessary number of harmonics estimation).

– Short-term forecast of stock prices and detection of the 'state of decision' for every company from the “perspective” set:” buy”, if the price is near the local minimum in current day and predicted price increases; “sell”, if the price is near the local maximum and the predicted price decreases; “hold”, in over cases.

Computer simulation has been fulfilled [5] in order to evaluate the performance of proposed method and algorithms using real stock prices data (Fig. 1).

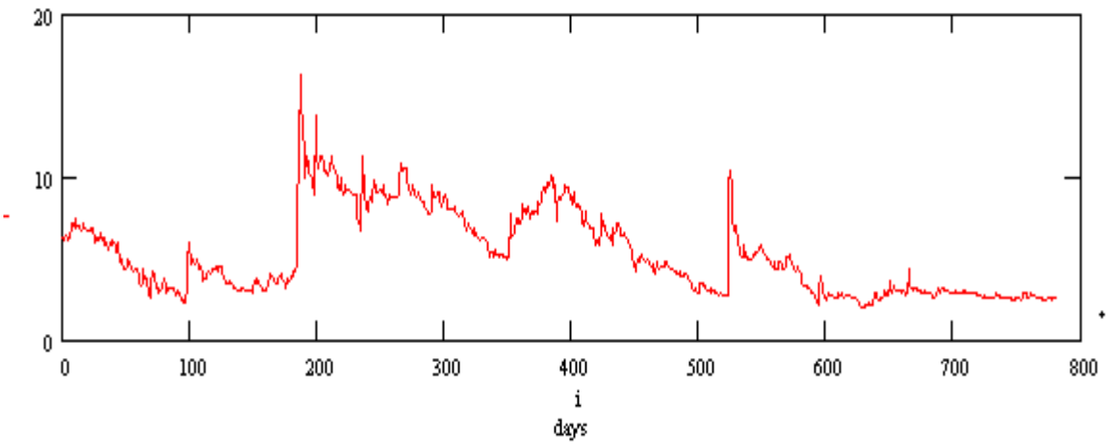


Fig. 1. **Stock price time series**

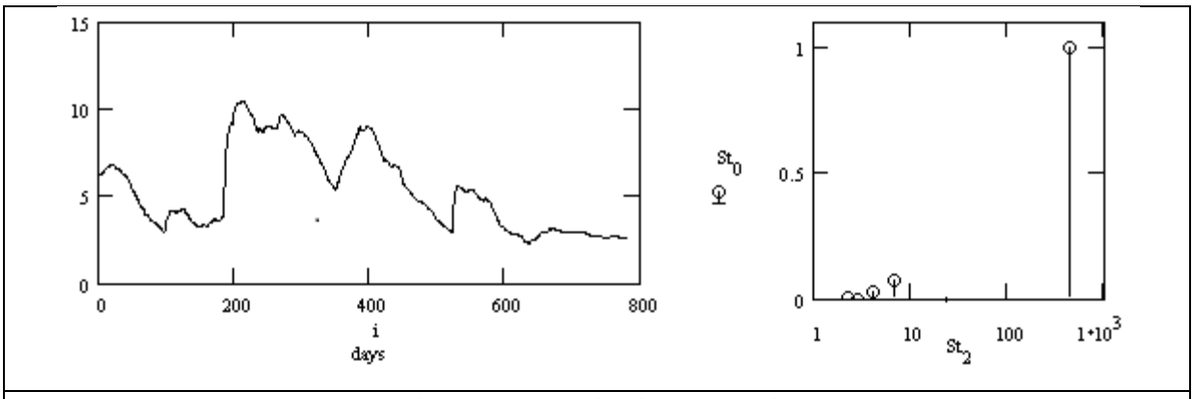
For each step the following calculations are performed:

– The initial time series is separated into the slow (trend) and fast (wave) components by means of some type of digital filtering algorithms.

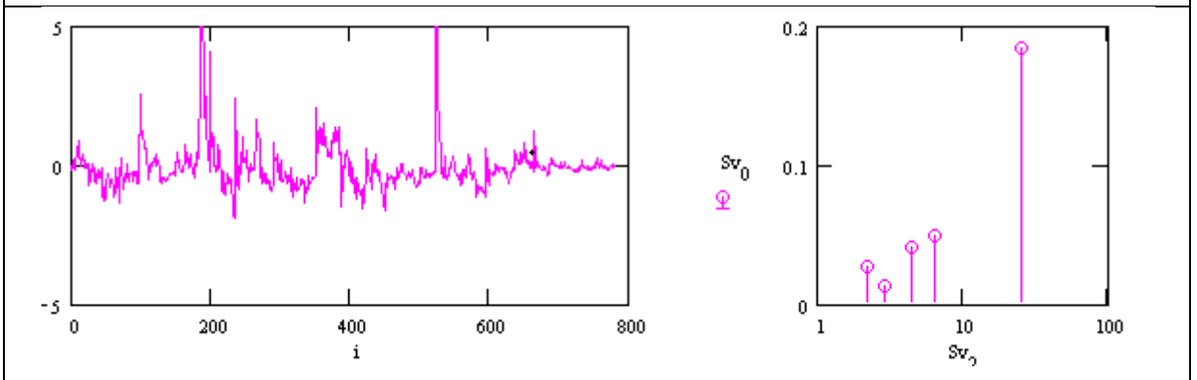
– The harmonic components of both trend and wave terms as well as first difference (time series changing velocity) are estimated.

The results of stock price structural harmonic analysis are illustrated in Fig. 2 (relative to time scale and period in days).

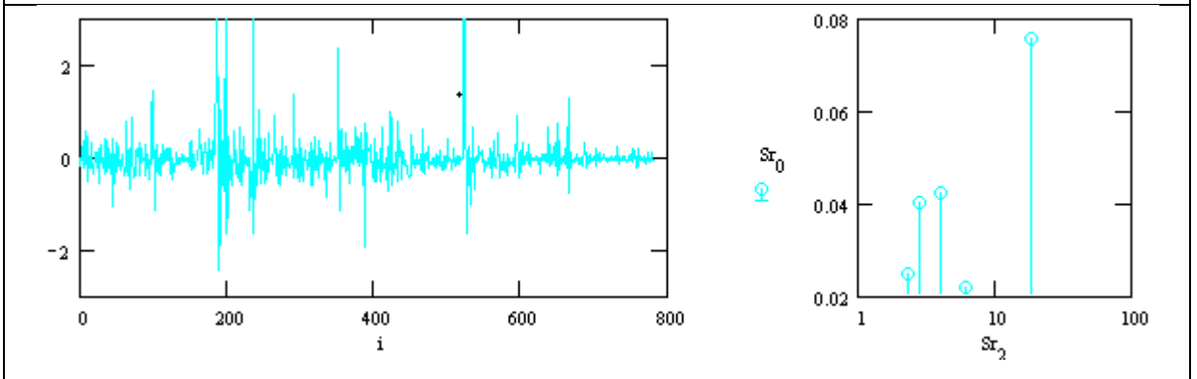
Short-term (5 days ahead) forecasting results is presented at Fig 3. The forecasted data are approximated by second-order curves and the local extremum are calculated. The decisions “buy” or “sell” is accepted if the estimated local minimum or maximum is located near the current day respectively.



A). Harmonic analysis of trend (slow) stock price component



B). Harmonic analysis of wave (fast) stock price component



C). Harmonic analysis of residual stock price component

Fig.2. **Time series decomposition and harmonic analysis**

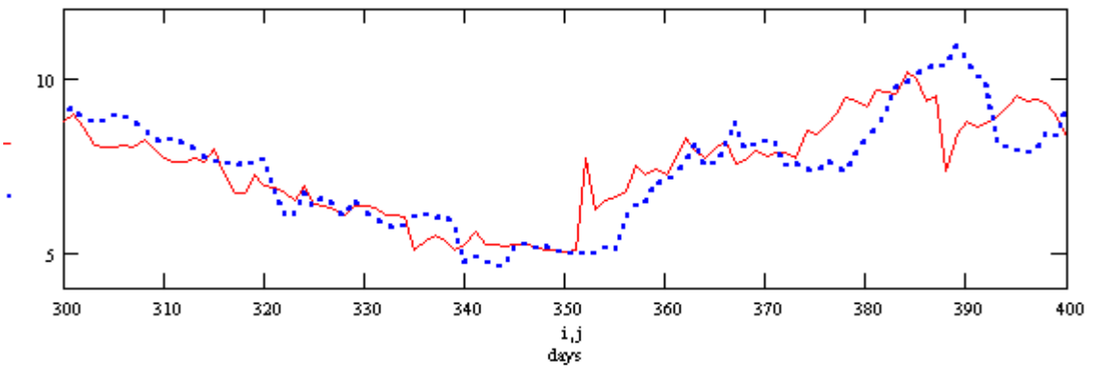


Fig. 3. **Five steps ahead stock price forecasting**

Passing on to the next steps the actual income or losses are calculated using the accepted decision and real prices. The simulation results demonstrate the stable grows of the income even in the case when the trend of stock prices has the tendency to the decreasing. Of course, it takes place only in a long period of trading when the frequency of a right decision exceeded the faulty one.

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