ANALYSIS AND MATHEMATICAL MODELING OF PROCESS OF CHANGING PRICES ON EXAMPLE OF JSC «SBERBANK»

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АНАЛИЗ И МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ ПРОЦЕССА ИЗМЕНЕНИЯ ЦЕН НА ПРИМЕРЕ АКЦИЙ ОАО «СБЕРБАНК»

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Математическое моделирование данных данных является крайне важным и полезным инструментом при проведении различных исследования,в том числе и научных, так позваляют изучать динамику и развитие различных процессов.

Ключевые слова: временной ряд, стационарность, линейная модель, прогнозирование, доверительный интервал.

The object of study. The object of study in this paper is time series, compiled from data on prices of shares of OJSC «Gazprom» (GAZP). The data were taken at intervals of one day in the period 03.02.2014 to 02.02.2015 (1 year).

Formation of the time series. On the basis of data on changes in stock prices during the study period time series, containing 251 observed value of each, were generated. After forming the analyzed time series, a graph showing the changes of the stock prices during the year was constructed (fig. 1, blue line).

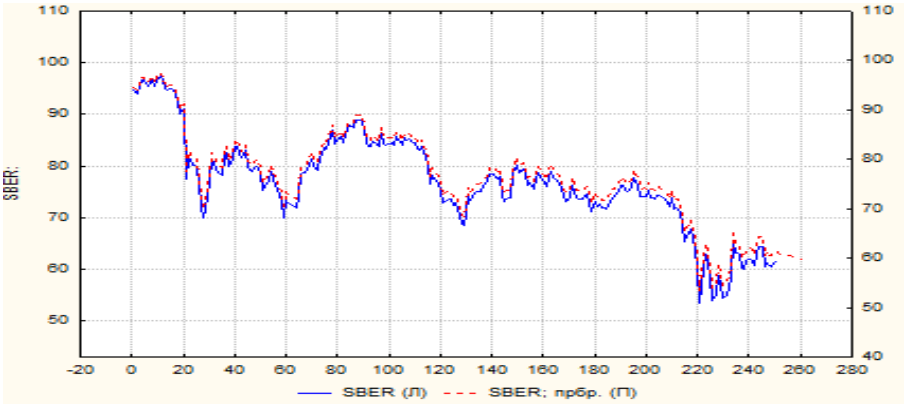

Fig. 1. The graph of prices for shares of JSC «Sberbank»

Time series analysis of prices of shares of «Sberbank». To start, the analyzed time series were tested for stationarity. To test this, the autocorrelation function (ACF) was constructed (fig. 2).

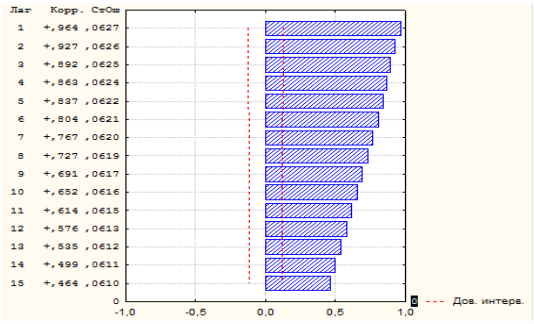

Fig. 2. ACF analyzed series

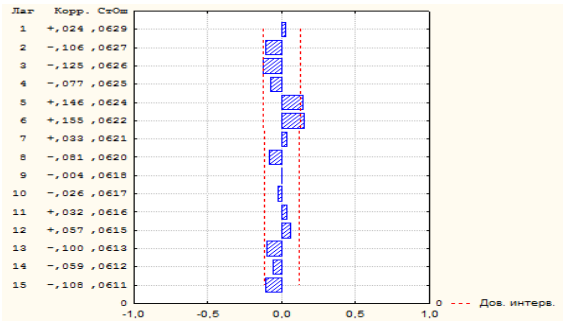

Fig. 3. ACF number of first difference

As can be seen, the autocorrelation function of the series does not decay, which indicats the number of non-stationarity. This assumption could be made at the stage of formation of a number, so fig. 2 shows on stock prices during the year tended to increase. Next, number of first differences for the test series was calculated. The resulting series was also tested for stationarity using the autocorrelation function (fig. 3).As a result, it was found that the original time series consisting of the prices of shares of «Sberbank»are integrable non-stationary time series of the first order.

Building a model of the time series of prices of shares of «Sberbank». To determine the best model ARIMA (p, 1, q), a model containing a variable number of parameters p and q will be considered. And since, in practice, it is easier to use a more compact model, to determine in advance that the maximum value of the parameters p and q is equal to 2. This implies that the choice of the optimal model will be made of the following models: ARIMA (1,1,0), ARIMA (1,1,1), ARIMA (2,1,0), ARIMA (2,1,1), ARIMA (2,1,2). The coefficients of the models selected in the program were assessed using Statistica with the least squares method. To select the optimal model, residues derived models were investigated. To do this, we calculated the following parameters: residual sum of squares (SS), the variance of residuals (MS). These figures indicate a variance calculated from the observed values. The results were as follows (Table 1):

Table 1

The coefficients of selected models

	ARIMA(1,1,0)		ARIMA(1,1,1)		ARIMA(2,1,0)		ARIMA(2,1,1)		ARIMA(2,1,2)	
α_0	–0,13	0,43	–0,13	0,3	–0,13	0,25	–0,13	0,19	–0,13	0,23
α_1	0,023	0,00	–0,73	0,01	0,02	0,68	0,44	0,03	0,84	0,00
α_2			–0,77	0,004	–0,11	0,09	–0,14	0,02	–0,85	0,00
β_1							0,42	0,03	0,81	0,00
β_2									–0,73	0,00
SS	988,58		985,14		977,39		968,18		937,12	
MS	3,98		3,98		3,95		3,93		3,82	

As a result, it was found that the best model for the investigated time series model is ARIMA (2,1,2). Model ARIMA (2,1,2) has the following form:

$$X_t = -0{,}13 + 0{,}84X_{t-1} - 0{,}85X_{t-2} + 0{,}81\varepsilon_{t-1} - 0{,}73\varepsilon_{t-2} + \varepsilon_t$$

The resulting model and the test of the time series were also plotted (fig. 1, red line).

Building on the basis of the forecast models for the price of shares of «Sberbank». On the basis of the model ARIMA (2,1,2) for the shares of JSC «Sberbank», we built forecast for the next three working days after the test period, namely on 03.02.2015, 02.04.2015, 02.05.2015. As a result, the forecast share price on 03.02.2015 is 60.91 rubles. (the actual price – 62 rubles., error – 1.7 %) on 04.02.2015 is 60.45 rubles. (the actual price – 61.04 rubles., error – 0.9 %) on 02.05.2015 is 61.01 rubles. (the actual price – 62.41 rubles., error – 2.2 %).

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