

Analysis Order Book with a Card of Kohonen

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Abstract—The properties of parameters order book of a financial instrument USD/RUB were studied. The paper studies some relationship between order book's parameters USD/RUB and the price movements on the graph on quarter timeframe. We have considered a series of standard and special indicators of order book. The investigation deals with the predicting the dollar price using parameters of order book prepared by Kohonen Self-Organizing Map. Several target prices were analyzed.

Keywords—Order book, Kohonen map, the forecast price of a financial instrument

I. INTRODUCTION

Application of Neural Networks in stock trading is essential in the modern world. A thorough study of the phenomenon was made. As research shows, that the information of order book is very important. A comprehensive study of the theoretical studies of various scientists on the forecast of stock prices was made. An extensive study was performed of the effect of the ratio of orders to buy and sell orders on the exchange price of the financial instrument USD/RUB on the chart.

A detailed analysis of the type clusters, the distances to the center of the cluster, numbering cells, the distances to the centers of cells, using Kohonen self-organizing maps has been carried out. An analysis was made of the research of modern scientists about the impact of the price of the order book. Scientific hypothesis was examined and it was shown that it is possible to prove that Kohonen self-organizing maps options of the impact of the price of the order book at the beginning of the opening of the candles on the 15 minute time frame, can allow to obtain predicted values prices USD/RUB at the close of the candle. It is concluded that the model provides a very good fit to the experimental data. The allocation purchase and sale of the bulk were described with particular attention to the structure of their various ranges of values.

It has been shown that the issues of portfolio management in the stock market with the help of artificial intelligence systems have dedicated their works, many scientists. The dollar exchange rate forecast has with using astrological cyclical indices Gyushon and Gan had been studied by Maximova O.N. [8]. The using of the neural network of the exchange trading robot in portfolio management have been investigated by Novaya E.A. [10], the theoretical bases of perfection of brokering

had been researched by Popovicheva N.S.[11], Nesterova A.O. studied the neural network model of money management [9].

The study was intended to establish dependence between the structure of applications for buying and selling in the stock and a glass on a chart the dynamics within a 15 minute period.

The aim of the study was to provide some information concerning the life and habits of these animals using Artificial Neural Networks in stock trading, but some issues require further theoretical study.

According to Bondarenko Y.A., it is necessary to continue research on profit prediction [1], the point of view Lomakin N.I. is that, fuzzy-algorithm is best suited for financial risk management in the stock transaction [6], and stock transactions are applicable to increase the investment activity of the enterprises of the real sector of the economy [4], large-scale using of the stock robots is rather useful in conditions of information society development [7].

II. TEXT OF THE ARTICLE

It was found that the order book is a table that contains information that is a digital display of the current market sentiment. Over the short-term analysis of the current market situation would have been done using information from the order book, for a specific financial instrument included in the portfolio.

Unlike graphs, which reproduce market information in a visual form, in exchange glass reflected application is only offered for Exchange close of the market price at a given distance from the market equilibrium. Applications, The applications was submitted to the order book, will be executed very soon and thus affect the movement of prices on the market [3].

The orders of big players are visible in the Quotes glass, and it can be used for trading decisions. The Quotation glass does not show a complete picture of the market. The Quotation glass didn't show a complete picture of the market, so, it is reflected not all the orders of the stock exchange. There are visible only a small part of the limit orders. Only limit orders, that are close to the market price are reflecting there.

Order book is included several parts: the green part - is an application for purchase (bid), in the red zone - an application

for sale (ask or offer). The market price is within the spread, ie Best price between buyer and seller is called better price.

The export off Quotation glass orders for the purchase and sale was performed using trader terminal QUIK. The histogram of stock warrants for the purchase and sale had been reflected in the Quotes glass top red candle in USD/RUS by 19.30. Diagrams are introduced to simplify the discussion (Fig. 1).



Figure 1. The histogram of stock warrants for the purchase and sale had been reflected in the Quotes glass top red candle in USD/RUS by 19.30

It's possible to suggest that the volume of orders to buy and sell, as well as their location in the glass at the beginning of "birth" of a candle are influenced on the behavior of asset prices in future. So it can be the basis to forecast the closing price of the current candle. Nine candles of USD/RUB were successfully imported from trading terminal QUIK to Deductor. The picture includes three parts - frames. In the top frame is the price chart candle of the first observations at 19.30 time, this candle has a red colour.

The index chart RSI (relative strength index) is placed on the middle frame. It is shown overbought market at values > 70 and oversold when values < 30 , thus predicting the imminent trend reversal.

In the lower frame MACD gistogram index (Moving Average Convergence/Divergence) is placed on. This index is reflected the birth and development of the fading trend. Dynamics of parameters candlestick is presented in Table 1.

Table I. DYNAMICS OF PARAMETERS OF USD/RUB

N	1	2	3	4	5
T	19.15	19.30	19.45	20.00	20.15
Po	60.05	60.06	60.1	60.14	60.14
Ph	60.07	60.1	60.15	60.15	60.15
Pl	60.02	60.04	60.1	60.12	60.12
Pc	60.07	60.1	60.14	60.15	60.13
RSI	54.2	57.88	57.88	62.27	59.2
MACD	0.010	0.012	0.016	0.022	0.028
N	6	7	8	9	
T	20.30	20.45	21.00	21.15	
Po	60.12	60.13	60.13	60.14	
Ph	60.14	60.14	60.15	60.15	
Pl	60.11	60.12	60.13	60.13	
Pc	60.14	60.13	60.15	60.15	
RSI	59.84	58.53	60.85	60.48	
MACD	0.026	0.02	0.18	0.01	

For the analysis of statistical parameters Deductor order book program have been used.

The input data were processed with the help of neural networks - Kohonen map. Kohonen self-organizing maps (SOM) is one of the varieties of neural network algorithms.[11].

Functioning of the self-learning algorithm maps (Self Organizing Maps - SOM) is one of the options for clustering multidimensional vectors. As an example of such an algorithm the algorithm can perform k-nearest medium (k-means).

The coordinates of the input vector are designated on cross marked. The map coordinates of nodes after the modification are marked in gray. Moreover, grid view after the modification is depicted by dashed lines. Diagram is introduced for the simplification of the discussion (Fig. 2).



Figure 2. Tuning the weights of the winner neuron and its neighbors

Besides the parameters of candlesticks, it's very important to use technical analysis indicators RSI and MACD relative strength index. RSI is a technical analysis indicator that measures trend strength and the likelihood of change [5]. Indicator Moving Average Convergence / Divergence is a technical indicator used in technical analysis to assess and predict price fluctuations on the stock and currency exchanges [6]. The program Deductor is used in data processing applications. It is also employed when investigating Kohonen Maps for the analysis of the statistical parameters of order book. Neural networks of this type are commonly used for a wide range of tasks, from data analysis to find patterns, for example, financial problems [19].

Moreover, it should be noted that an important difference between SOM algorithm is that it all neurons (nodes classes centers ...) arranged in a certain structure (usually a two-dimensional grid). Then in the course of training is modified not only the neuron-winner, but also its neighbors, but to a lesser extent. The parameters Kohonen maps at the beginning of the first candle are represented on the screenshot. The diagram can be plotted (pic. 3).

The total aggregate of buy orders is divided into six ranges.

It should be noted that the ranges have a symmetrical distribution with respect to the market equilibrium in terms of supply and demand. The bulk of the orders 27 (67.5 percent) is located within the range of the size of orders from 0 to 216.833 and then leads to a range of sizes from 433.666 to 650.5 comprising 6 orders (15.0 percent).

Similarly, we can see the histogram of frequency allocations for other parameters and, if necessary, to use them in the "perceptron" - neural network model to predict the closing

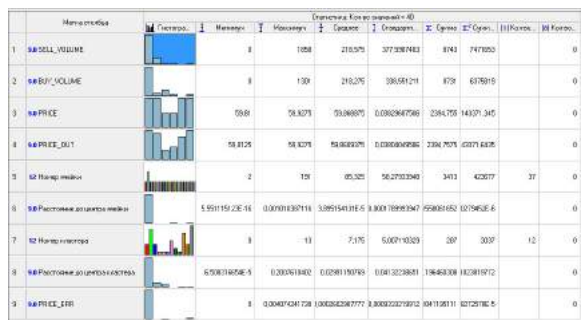


Figure 3. The settings order book the beginning of the first candle USD/RUB

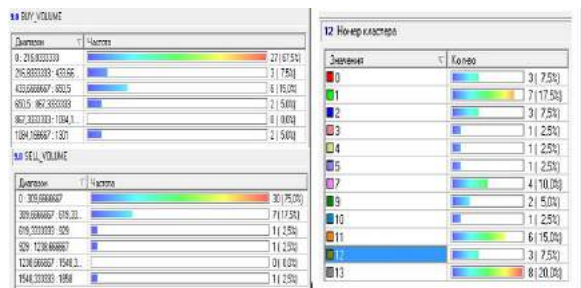


Figure 4. The frequency of the basic parameters

price of USD / RUB at the end of the candle. Diagrams are introduced to simplify the discussion (Fig. 4).

Numerous figures show that the spectrum contains a very broad frequency ranges for different. The rate calculated for all available software options are very important for research. The frequency for histogram "price" were distributed as follows. Diagram is introduced in order to simplifying (Fig. 5). The



Figure 5. Frequency histogram "price" were distributed

frequency allocation spectrum consists of two types of components - 8(20,0) and 4(10,0). As we see, Deductor program allows you to calculate the required parameters: the cell number, the distance to the center of the cell, cluster number, the distance to the cluster center, the amount of error in the price. The Deductor program which makes use statistics method of detecting is described. Statistics obtained are important for research. For the simplification of the discussion diagram is introduced (Fig. 6)

The necessary mathematical data were received after the training neural model. They characterize the feature of the composition and structure of the order book. We can plot a diagram (Fig. 7).

The formula is used to modify the weighting coefficients:

SELL_VOLUME	BUY_VOLUME	PRICE	PRICE_OUT	Номер кластера	Расстояние до центра кластера	Номер кластера	Расстояние до центра кластера	PRICE_ERR
590	0	59.9275	59.925	130	2.0230641261718E-9	3	0.0613444811666212	0
503	0	59.925	59.925	128	1.0147389672518E-9	9	0.0002719123232800	0
600	0	59.925	59.915	117	9.59111512912071E-16	7	0.003792791646032	0.004742417303447
691	0	59.92	59.92	101	0.0002626000000E-12	5	0.01280491075495	0
347	0	59.9175	59.9175	100	2.071386163719E-9	10	0.0125069031542959	0
600	0	59.915	59.915	117	9.59111512912071E-16	7	0.003792791646032	0
612	0	59.9125	59.9125	100	2.071386163719E-11	7	0.0027300000420863	0
1890	0	59.91	59.91	176	1.5304250091312E-9	4	0.000461570000445203	0
600	0	59.9075	59.915	117	9.59111512912071E-16	7	0.003792791646032	0.004742417303447
1162	0	59.905	59.905	163	6.44770834100381E-10	3	0.021424232335863	0
190	0	59.9025	59.9025	96	1.57460130118118E-9	11	0.02408115191910	0
211	0	59.9	59.9	89	4.693120000020E-9	11	0.002760006702282	0
260	0	59.8975	59.8975	66	7.21952306160771E-9	11	0.02254659372962	0
208	0	59.895	59.895	65	4.0746507430005E-9	11	0.00388489407076E-6	0
170	0	59.8925	59.8925	35	1.48930420820246E-6	11	0.0159120091983029	0
52	0	59.89	59.89	53	7.86930438274310E-7	13	0.022516091104494	0
16	0	59.8875	59.8875	5	0.0002379406999005E-5	13	0.017700071691234	0.00045269562684325
15	0	59.885	59.885	5	2.6744820174970E-7	13	0.017700071691234	0
200	0	59.8825	59.8825	2	3.8029740713762E-9	11	0.0031841616420093	0
30	0	59.88	59.88	37	7.6197959024010E-7	13	0.0217632925175851	0
0	46	59.88	59.88	24	2.84252163781078E-9	13	0.0225244822206167	0
0	300	59.8775	59.8775	74	1.2009040299414E-7	12	0.0129236736352389	0
0	1	59.875	59.875	22	2.145434946015E-6	13	0.0220190114456084	0
0	262	59.875	59.875	44	1.162147068012E-7	2	0.0125490415597626	0
0	354	59.8725	59.8725	12	5.14386730633914E-9	2	0.04217305204193	0
0	4	59.87	59.87	7	3.1300410171544E-7	13	0.019104039161077	0
0	15	59.8675	59.8675	23	2.01020410020710E-7	13	0.016800004670782	0
0	950	59.84	59.84	138	4.0344819544323E-9	1	0.024849996767464	0
0	151	59.8375	59.8375	87	9.303550995054E-7	12	0.0095441039182093	0
0	261	59.835	59.835	14	1.27432182018371E-6	2	0.038888884406963	0
0	1100	59.8325	59.8325	158	1.0772800613192E-7	2	0.0424446479130995	0
0	107	59.83	59.83	55	3.0847689899917E-7	12	0.042623403896444	0
0	800	59.8275	59.8275	170	1.45549109992046E-9	1	0.0072973876712671	0

Figure 6. The parameters Kohonen maps at the beginning of the first candle

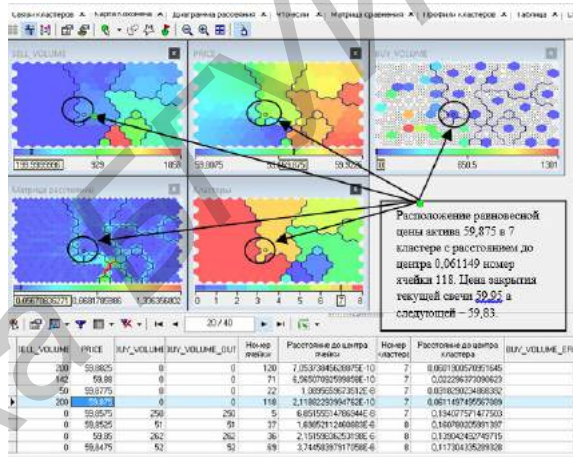


Figure 7. Kohonen map for glass candle at 19:30 times

$$wi(t + 1) = wi(t) + hci(t)?[x(t) - w(t)]wi(t + 1) = wi(t) + hci(t)?[x(t) - w(t)]$$

where t - denotes the epoch number (discrete time); x (t) - vector selected randomly from the training sample at iteration t; h (t) - function is called neurons neighborhood.

The meaning of the equilibrium price of the asset at 19.30 time is 59.875. The value of this parameter is located in 7-cluster distance to the center of 0.061149 cell number 118. The closing price of the current candle is 59.95 and the following candle - 59.83. Thus, such "image clusters" corresponds with "declining market".

The function "What-if" in the program Deductor makes it possible to calculate the predicted value of the closing of the next candle - 59.89. In order to simplify the discussion diagram is introduced (Fig. 8).

Kohonen map is provided a high accuracy of the forecast. The deviation of the actual value of the asset price 59.89 from the actual 59.89 is amounted to 0.06, so error value is not exceeded 0.001.

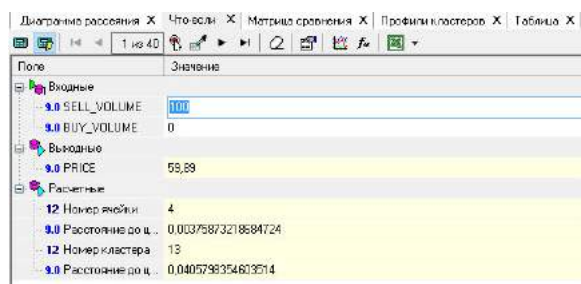


Figure 8. Predictive value of the closing price of the USD / RUB 59,89 at the actual value of 59,83

III. CONCLUSION

Investigation of the dynamics parameters order book is very important. It made it possible to get a forecast price for change of supply and demand of speculators in real time. This approach has the advantage in comparison with the results of a technical analysis, which is based on data from the past.

A new method has been developed to produce the forecasts financial instrument price USD/RUB. The scientific research supports assumption. Thus, on the basis of the above we can conclude that:

- firstly, some relationship between order book's parameters USD/RUB and the price movements on the graph on quarter timeframe was found;
- secondly, an extensive study was performed of the effect of the ratio of orders to buy and sell orders on the exchange price of the financial instrument USD/RUB on the chart;
- thirdly, the detailed analysis of the type clusters, the distances to the center of the cluster, numbering cells, the distances to the centers of cells, using Kohonen self-organizing maps has been carried out;
- fourthly, the analysis was made of the research of modern scientists about the impact of the price of the order book;
- fifthly, scientific hypothesis was examined and it was shown that it is possible to prove that Kohonen self-organizing maps options of the impact of the price of the order book at the beginning of the opening of the candles on the 15 minute time frame, can allow to obtain predicted values prices USD/RUB at the close of the candle.
- sixthly, it becomes possible to use the algorithm in the stock trading robot.

It will automate the process of deciding whether to buy / sell an asset at a scalping [5], developed method will have been to design more successful trading robots [12].

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АНАЛИЗ БИРЖЕВОГО СТАКАНА С ПОМОЩЬЮ КАРТЫ КОХОНЕНА

Ломакин Н.И., Орлова Е.Р., Нересов В.С.

В статье проведен анализ взаимосвязи параметров биржевого стакана финансового инструмента USD на пятнадцатиминутном таймфрейме и движения цены на графике. Для проведения исследования использовался алгоритм нейронной сети - Карта Кохонена. Учитывались такие параметры, как количество заявок на покупку и на продажу на различных ценовых уровнях финансового инструмента в биржевом стакане. Во внимание принимались рассчитываемые параметры стакана, как минимальные, максимальные и средние значения объемов продаж, объемов покупок и цены, их средние значения и стандартные отклонения. Кроме того, с помощью Карты Кохонена рассчитывались значения кластеров и распределение параметров по кластерам в абсолютном выражении и их веса. Анализ проводился с целью подтвердить или опровергнуть гипотезу о том, что динамика параметров биржевого стакана может выступить генератором факториальных признаков для прогнозирования направления и амплитуды движения USD в японских пятнадцатиминутных свечах. Исследования показали, что с помощью анализа выявленных факториальных признаков можно спрогнозировать движение цены актива. Результаты анализа представляют интерес по поводу оценки движения цены биржевого актива.