DETECTION OF A STATISTICALLY SIGNIFICANT JUMP IN PRICES OF RISKY ASSETS IN INTRADAY TRADING

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Introduction

The aim of this work: detection of statistically significant jumps in prices of risky assets in intraday trading.

Analysis of empirical data

The study of intraday increments of shares of 10 Russian companies in the MICEX-10 was conducted. These are OAO "Gazprom", OJSC "MMC" Norilsk Nickel", OAO" LUKOIL ", OJSC" Magnit ", OJCS "Mobile TeleSystems, OJSC "Novatek" JSC "NK Rosneft", OJSC "Sberbank of Russia", JSC "Sberbank of Russia - n", JSC "VTB". During the period from May 9 to August 9, 2014.

Further progress will be presented on the example of one of the ten stocks listed above, namely, the example of the shares of OJSC "VTB".

Figure 1 shows the share prices of OJSC "VTB" for the period from May 9 to August 9, 2014.
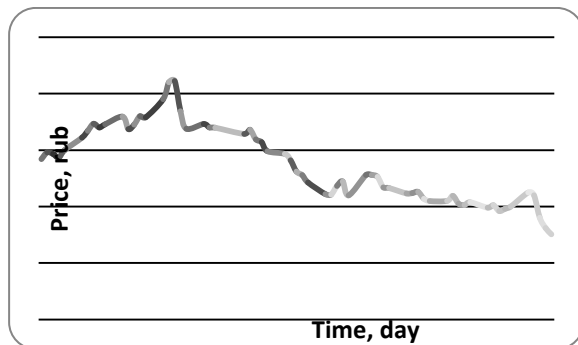

Fig. 1. Shares of OJSC "VTB" for the period from 05/09/14 to 09/08/14

Frequency of data was 60 minutes, 30 minutes and 15 minutes. For each period, intraday corresponding increments were calculated in accordance with formula 1,

$$r_{i,t,j} = p_i(t-1+j/M) - p_i(t-1+(j-1)/M), j = 1,2,...,M \quad (1)$$

then the realized variation was calculated in accordance with formula 2

$$RV_{i,t} = \sum_{j=1}^{M} r^2_{i,t,j} \quad (2)$$

and as component quadratic variation was calculated according to formula 3,

$$BV_{i,t} = \mu_1^{-2} \left(\frac{M}{M-1} \right) \sum_{j=2}^{M} |r_{i,t,j}| \, \|r_{i,t,j-1}|, \quad (3)$$

where $\mu_1 = \sqrt{2/\pi} \approx 0.7979$

Thus, the contribution to the total variation can be assessed by the indicator of the relative jump and calculated by formula 4.

$$RJ_{i,t} = \frac{RV_{i,t} - BV_{i,t}}{RV_{i,t}} \quad (4)$$

In advancing the statistical hypothesis about the availability of, at least, one jump, and taking into account the normal distribution of z-statistic, number of days was assessed, in which there were a significant spikes in the price of assets.

Test statistic calculated by the formula 5, 6 [1]

$$z_{i,t} = \frac{RJ_{i,t}}{\sqrt{(v_{bb} - v_{qq}) \frac{1}{M} \max\left(1, \frac{TP_{i,t}}{BV^2_{i,t}}\right)}}, \quad (5)$$

where $v_{qq} = 2$, $v_{bb} = \left(\frac{\pi}{2}\right)^2 + \pi - 3 \approx 2.6090$,

$$TP_{i,t} = \mu_{4/3}^{-3} M \left(\frac{M}{M-2}\right) \sum_{j=3}^{M} |r_{i,t,j}|^{4/3} |r_{i,t,j-1}|^{4/3} |r_{i,t,j-2}|^{4/3} \quad (6)$$

$$\mu_{4/3} = 2^{2/3} \Gamma\left(\frac{7}{6}\right) / \Gamma\left(\frac{1}{2}\right) \approx 0.8309$$

Table 1 shows the number of days in which there were a significant spikes in the price of assets for each of the periods.

Table 1.

Number of days with splashes of asset prices (out of 63 possible)

	60 minutes	30 minutes	15 minutes
12. Gazprom	6	14	23
13. NorNickel	7	12	19
14. LUKOIL	3	17	24
15. Magnit	11	20	31
16. MTS	5	11	22
17. NovaTek	12	19	28
18. Rosneft	14	22	36
19. Sberbank	2	10	17
20. Sberbank - p	2	8	16
21. VTB	8	17	25
22. MICEX - 10	9	18	24

Analyzing the data in Table 1, it can be concluded that with an increase in the length of the time interval decreases the number of arbitrage opportunities.

Next we perform statistical hypothesis testing on the presence of at least one significant jump in the trading day on the example of the shares of OJSC "VTB" for periods of 60, 30 and 15 minutes.

Values z - statistics are marked by blue solid line, the critical value of z - statistic with a probability of 0.95 are marked by red line.
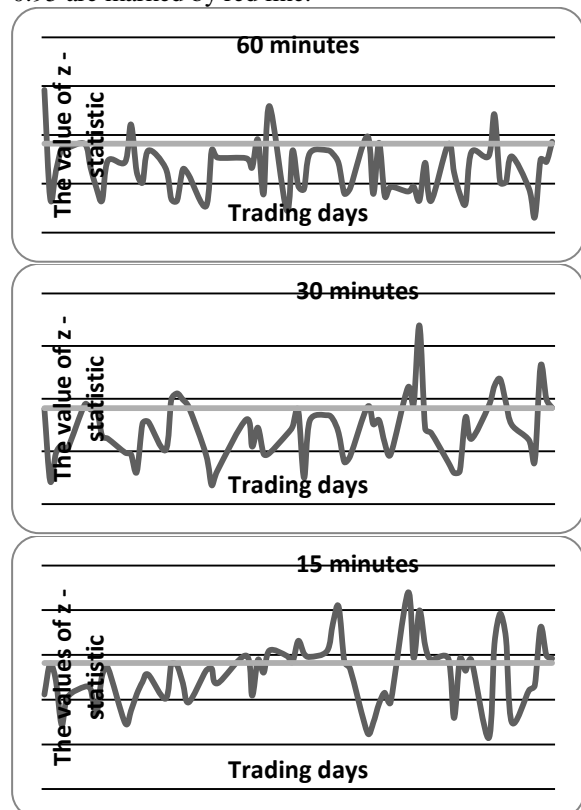

Fig. 2 – 4. values of z-statistics for the company shares of JSC "VTB" at different time intervals: fifteen minutes, half an hour and an hour

Analysis of Figure 2 - 4 shows the increase in the number of significant quantities of statistics with decreasing time interval. It confirms the conclusion obtained in the analysis of Table 1.

Table 2 shows the jumps and their quantities for the company shares of JSC "VTB" in the concerned period.

Table 2.

The distribution of shocks for different time intervals for the shares of OJSC "VTB"

The size of the jump	15 min	30 min	60 min
	The number of jumps	The number of jumps	The number of jumps
Total number	2259	1130	567
No change	530	344	121
< 0,1	348	129	74
0,1 – 0,3	521	271	126
0,3 – 0,5	660	299	183
0,5 – 0,7	196	83	60
0,7 <	4	4	3

Based on Table 2 it is possible to track the average magnitude of the jump and the average stock returns. The values for the shares of OJSC "VTB" are shown in Table 3.

Table 3.

Mean values of jumps and yields for stocks of OJSC "VTB"

	15 min	30 min	60 min
The average size of the jump, %	0,22	0,23	0,24
Total number of jumps	2259	1130	567
The average yield for the whole period, %	497	260	136

Analysis of Table 3 shows that with increasing of length of the time interval, increase in the average size of the jump is observed, but the average yield is reduced.

This work has been done for all the other 9 issuers included in the MICEX index - 10.

Further action was the comparison between individual issuers included in the MICEX - 10 with the MICEX index - 10 In the course of this comparison for the MICEX index - 10 intraday jumps were identified, using statistical methodology. The number of jumps were estimated, which revealed arbitrage opportunities for the investors, for more profit in the stock market. Statistical hypothesis that abrupt changes in trading days in the calculations at time intervals of different lengths was updated. The average jumps and the average yield for the periods were calculated.

Conclusion

On the basis of this study we can conclude that the most effective solution is to invest in individual issuers included in the MICEX index - 10, and it is the most liquid shares of "Rosneft", "Novatek" and "Magnet". The least liquid are "Sberbank", "Sberbank - n" and "Lukoil".

Literature

Tim Bollerslev, Tzuo Hann Law, George Tauchen. Risk, jumps, and diversification. — Journal of Econometrics 144 (2008) 234–256.