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Analysis of trading algorithms on the platform QUIK

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Introduction

An electronic trading platform is a program complex for the communication, processing, and calculations that can be used to place financial orders (buy/sell) for securities. Security is a tradable financial instrument and has a monetary value. This financial instrument represents an ownership position in a publicly-traded corporation. QUIK (Quickly Updatable Information Kit) is the most popular trading platform in Russia and Ukraine for access to national trading exchanges.

Prediction of changes in market prices can be implemented using a fundamental analysis based on the manufacturing and financial information, or technical analysis, based on the creating and analysis of charts based on the main indication values: price, volume, time. Fundamental analysis requires expertise to describe and interpret economic factors that can affect the value of securities. At the same time, charts reflect the complete and actual information, and it can be interpreted in simple ways. Despite criticism from supporters of classical fundamental analysis, claiming that technical analysis does not consider the causes of price changes, it has been successfully used to detect entry points. The entry point is the moment of the shift of the trend in price changes, from trend or the state without an obvious trend. The technical analysis was developed for the 20th century but became especially relevant after the appearance of online trading, which allows the trader to get charts using real-time data. Methods of analysis and interpretation are continuing to be explored and improved, comparison analysis of the effectiveness effect of methods is an important and relevant area in modern stock trading.

For effective and continuous work on the electronic trading platform, trade algorithms are applied. In electronic financial markets, algorithmic trading refers to the use of computer programs to automate one or more stages of the trading process: pre-trade analysis (data analysis), trading signal generation (buy and sell recommendations), and trade execution. A trading algorithm is a clear action plan on an electronic trading platform that includes a behavioral model, a schedule of operations, and a record of the current time relative to the start and finish of trading. Automation is provided for trading algorithms, which will allow us to instantly buy and sell securities portfolios when the conditions described in the behavioral model.

This paper analyzes the set of trading algorithms A . An element of this set is $a(I, C_s, C_p)$ where I is a set of indicators of which behavior is taken into account for a given trading algorithm. Indicators are tools that perform specific computations using specified formulas based on price chart values, and then automatically produce a result. Most often, the indicators look like graphical constructions (lines, histograms, etc.) that are plotted on the chart in automatic mode. C_s is the set of conditions for the behavior of the indicators of the set I under which the sale is made, C_p is the purchase, respectively.

For each under investigation algorithm $a_i(I, C_s, C_p)$, the expected profit E_i is calculated at the end of the set operating time of the algorithm T . Based on these data, the most efficient trading algorithms are defined.

In algorithmic trading, exchange trading using trading algorithms, there is a significant correlation between the quantity/quality of the data available for analysis and the success of the trading system. For this reason, we are using a free QUIK demo account. In this way, we can get large datasets for experiments and analysis without real investments.

For our case, we get real-time and historical data for the drawn set of instruments. It is a date of candlesticks for all time for the 1-minute interval. candlestick chart - chart of interval type. It is popular in technical analysis, it consists of "candles" corresponding to a time interval of a preassigned value. Data of candlestick have a date, time, open price, high price, low price, close price, the volume of transactions.

Built-in scripted programming languages QPILE (QUIK Programmable Interface and Logic Environment) and Lua are supported in the QUIK electronic trading platform. The scripted programming language allows developing a script that is executed by the system. The script is a program that works with ready-developed software components, in our case, with the QUIK trading platform. However, QPILE updates are discontinued, and it continues to be supported due to the large number of existing algorithms. In order to the greater relevance, simplicity of work and language development for the implementation of trading algorithms, in this work is using the LUA scripting programming language.

Literature review

Details about the QUIK trading platform, realization, and the functionality can be found on the official website [1].

The book [2] describes the basis of technical analysis, forecasting prices on charts, an argumentation and methods for using indicators, methods for interpreting technical means, and a review of securities markets. The securities market is economic relations regarding the circulation of securities between market participants, and the issue of securities.

In article [3], algorithmic trading can be considered as a system with five stages:

- Data access/cleaning – access and deleting after using financial, economic, social data that will be supplied for algorithmic trading
- Pre-trade analysis – properties, behavior, predictions of securities to identify trading opportunities using data analysis.
- Trading signal generation based on the pre-trade analysis of what and when we need to trade.
- Execution of the transactions for the selected securities.
- Analysis of results after the trading activity the counting of the finite difference between the price when a buy and the price when a sell, analysis of decisions of algorithms.

Pre-trade analysis conducted through indicators that using historical data.

The official site of BCS Bank [4], which provides a demo account, contains information about technical indicators built into the QUIK platform, with a brief description.

In the article [5], there is a description of the development of models using various machine learning methods based on information received from a group of indicators and a training sample. Machine learning is a class of artificial intelligence methods, where historical data analysis is used to solve problems, make forecasts, and take decisions. In the capacity of input data was taken eight of the most popular technical indicators. The investigation was conducted for free transactions and transactions with cost that approximate to a real market cost transaction. For experimentation with these methods a period of 15 minutes was chose and methods were tested on real data for three months. In case when the cost of a transaction is zero, all models showed positive results, however, in case of nonzero transaction cost even the most efficient model was not able to get a stable profit. One of the main results of the article is that combinations of indicators give more significant signals than isolated indicators.

Chapter 1. Construction of trading algorithms

The main purpose of the algorithm is tracking fluctuations in the behavior of securities prices and automatically quickly placing orders. It is important to consider the commission of the trading platform. Typically, a commission is chargeable when a transaction is made and the size of the commission depends on the value of the transaction. Besides, a monthly fee for bidding is used, the size of value for it is fixed and, with a sufficiently large volume for business, it's insignificant. The tracking of fluctuations is based on the analysis of data from 3 indicators. This number corresponds to the number of main descriptors of the price chart. Thus, three technical indicators can provide sufficient information for decision-making.

It is important that the indicators not only report on changes in value, but also on the likelihood of maintaining the emerging trend for a minimum period of time for profit. Thus, for this, indicators can be used that report on the trend in price changes and the degree of involvement of exchange participants in trade in the selected market.

The indicator behavior is determined by the formula of finite difference:

$$v_i = \frac{value_n - value_1}{n}, i = 1, \dots, m$$

m – quantity of indicators

n – power of the set of indicator's values, by which its behavior is determined.

The indicator's value is determined by the corresponding candlestick of the security's chart. So we will take *value_j* is equal to the average value of the minimum and maximum for the *j*'s candlestick.

We assume that the indicator *i* “increasing” if the corresponding finite difference $v_i > 0$ and “decreasing” if the corresponding finite difference $v_i < 0$.

l – the number of indicators that must be increasing/corresponding to place an order. If the number of indicators with uniform signs less than *l*, security is “oscillating” and the algorithm doesn't place orders.

For analysis of results, we obtain the operating values for a certain period and information on securities and technical indicators when a sale or purchase took place.

Indicators should report not only about changes in price but also about the behavior of trend and traders' interest.

1.1 Technical indicators provided by trading platform QUIK

Since the release of technical analysis, hundreds of indicators were created. We will distinguish 3 main types: trend indicators, oscillators and volume indicators.

Trend indicators. A trend is a direction in which prices change. It can be upward and downward. Trend indicators can determine the direction and strength of the trend. On the other hand, it works with delay, and also in the absence of a

significant trend in the market, they can afford false signals. Often, indicators of this group are built based on a moving average. Moving average is calculating by the formula below:

$$MA = \frac{A_1 + A_2 + \dots + A_n}{n},$$

A_i – average in period i

n – number of periods

Moving average is a popular indicator that helps smooth out price chart.

Oscillators can track fluctuations in the flat - a part of the price chart in which there is no visible significant trend, and they are used to confirm or refute the continuation of the trend. With the view to detect local minimum or maximum, the oscillator estimates values of the overbought and oversold for securities at the moment. Overbought occurs when there are no potential buyers and there are only sellers are active participants. This state signals a price decreasing soon. Oversold, respectively, characterizes the opposite state, and signals for a probable price increase in the future.

Volume indicators. The number of completed transactions for a certain period reflects the interest of traders in trading in this market. Volume indicators are rarely used independently. However, an increase in the number of completed transactions, both for purchase and sale, can confirm the presence of a entry point that leads to a change in the trend on the price chart.

Often traders use complex indicators, such as the Ichimoku indicator, Bollinger lines, Alligator, and others [7] that can find the classic premises of entry point, support, and resistance levels. The support level is using as the lower limit of the price for an upward trend, if the price chart falls below this level, this indicates a possible change of trend. The resistance level for a downward trend works analogously. Such indicators contain several lines on the chart, according to the relative position of each other and the price line of the security, the expert interprets the price behavior. However, these technical indicators are ineffective for automatic analysis by using difference; the rising or falling of individual lines and even their average value is often not significant and it makes no sense to use these indicators in algorithms of the proposed type.

For demonstration complex indicators we will describe an example of such technical indicator - the Ichimoku cloud. This indicator was published in the late 1960s by Goichi Hosoda, a Japanese journalist. It consists of five simple indicators that show support and resistance levels.



Pic.1.1 Indicator Ichimoku cloud

$$\text{Tenkan (Conversion Line)} = \frac{9 - PH + 9 - PL}{2}$$

$$\text{Kijun (Base Line)} = \frac{(26 - PH + 26 - PL)}{2}$$

$$\text{Senkou span 1 (Leading Span 1)} = \frac{CL + \text{Base Line}}{2}$$

$$\text{Senkou span 2 (Leading Span 2)} = \frac{52 - PH + 52 - PL}{2}$$

Lagging Span (chikou span) = Close plotted 26 periods in the last
 Where PH-Period high, PL- Period low, CL-conversion line.

Traders using the Cloud as an area of support and resistance depending on the relative location of the price. Also, the advantage of this indicator is a large time of prediction of this area.

List of indicators provided by the QUIK platform:

2.1 Trend indicators

- ADX(Average Directional Movement Index)
- Alligator
- AMA (Adaptive Moving Average)
- Ichimoku
- MA(Moving Average)
- Fractals (by Bill Williams)
- Bollinger Bands
- Envelopes
- Parabolic SAR (Parabolic Stop and Reverse, Параболическая Система SAR)
- Price Channel

2.2 Oscillators

- Bears/Bulls power

- TRIX (Triple Exponential Moving Average)
- Williams' A/D (Williams' Accumulation/Distribution)
- Relative Vigor Index (RVI)
- Williams' % Range (Williams' %R)
- AC (Acceleration/Deceleration)
- AO (Awesome Oscillator)
- CMO (Chande Momentum Oscillator)
- MACD (Moving Average Convergence/Divergence)
- Momentum (indicator of market's speed)
- Price Oscillator
- Rate of Change (ROC)
- Relative Strength Index (RSI)
- Stochastic Oscillator

2.3 Volume indicator

- A/D (Accumulation/Distribution)
- Chaikin Oscillator
- BW MFI (Bill Williams' Market Facilitation Index)
- Elders Force Index
- MFI (Money Flow index)
- On Balance Volume
- Volume Oscillator
- ATR (Average True Range)
- CCI (Commodity Channel Index)
- Chaikin's Volatility
- Vertical Horizontal Filter

While trend indicators can be used separately, oscillators and volume indicators are more likely to have a complement value. However, to confirm the presence of a new trend, the pace of trade and the interest of buyers, interpreted in complement indicators, have an important role. Thus, for the compilation of algorithms, we will select trend indicators, and then, complement indicators, most effectively supplementing them.

1.2 Selection of a set of technical indicators used in algorithms based on their conformance among themselves and for selected the method of interpretation

After excluding complex trend indicators that are poorly interpreted by the difference, we get the list of applicants most suitable for the proposed method that can be used in the algorithm:

- AMA
- SAR
- MA

Oscillators:

- RSI
- TRIX
- Williams' A/D
- AC
- AO

Volume indicators:

- A/D
- Chaikin Oscillator
- BW MFI
- Elders Force Index
- On Balance Value
- Volume oscillator

The first set is basing on the most simple and reliable indicators.

The adaptive moving average is an indicator built based on the classical moving average with an improvement that allows more efficient use of the moving average in a period of weak trend due to the "efficiency ratio". This value is calculating as follows:

$$\text{Efficiency Ratio: } ER = \frac{|(P_i - P_{i-n})|}{\sum_1^n |P_i - P_{i-1}|}$$

Where P – closing price, N – number of periods, P_{i-n} – price n of security n periods ago.

Fast smoothing Constant(Fast) = $\frac{2}{p-1}$, where p – «fast» constant of average period.

Slow smoothing Constant(Slow) = $\frac{2}{q-1}$, where q – «slow» constant of average period.

$$SSC = ER * (Fast - Slow) + Slow,$$

$$AMA = AMA_{i-1} + SSC^2 * (P_i - AMA_{i-1}) \quad (1)$$

In the capacity of an oscillator, we will choose the popular, and often used with the adaptive moving average, relative strength index (RSI). This oscillator is easy to interpret and it shows a good risk-quality ratio. RSI can detect overbought and oversold conditions, which allows us to determine the entry point, both during the flat and during a significant trend. This indicator is calculated based on two exponential moving averages:

$$EMA_t(p, n) = \frac{1}{n} * p_t + \left(1 - \frac{1}{n}\right) * EMA_{t-1},$$

n – period,

$$EMA_0(p, n) = \frac{p_0}{n}$$

$$RS = \frac{EMA(\text{upward change}, n)}{EMA(\text{downward change}, n)}$$

$$RSI = 100 - \frac{100}{1+RS} \quad (2)$$

To an analysis of information about the volume of transactions, as well as the dispersion of prices, which also indicates the instability of the market, and therefore the likelihood of a entry point, we will use the classic indicator of balanced volume (OBV):

$$OBV_n = OBV_{n-1} + \begin{cases} volume_n, & \text{if } close_n > close_{n-1} \\ 0, & \text{if } close_n = close_{n-1} \\ -volume_n, & \text{if } close_n < close_{n-1} \end{cases} \quad (3)$$

$$OBV_0 = volume_0$$

First set of indicators:

- AMA
- RSI
- OBV

The next sample of technical indicators for the second algorithm, respectively, will contain a parabolic SAR indicator (Stop and reverse). This indicator represents a support level for a downward trend and a resistance level for an upward trend, that is, a line that prices, following the trend, are not likely to cross. The indicator is calculated as follows:

$$SAR_{n+1} = SAR_n + a * \begin{cases} high - SAR_n, & \text{if trend is upward} \\ low - SAR_n, & \text{if trend is downward} \end{cases} \quad (4)$$

The direction of the trend is considered changed when the price crosses the level formed by the SAR.

$$SAR_0 = price_0,$$

a is an acceleration factor, coefficient of the strength of changing, it is equal to a predetermined step l at a entry point when the price reaches a new limit value, a maximum for an upward trend, and a minimum for a downward trend, increases by a step l . When a factor reaches the maximum value m , the growth of the acceleration factor stops.

Parabolic SAR is more difficult to interpret than the moving average, however, it generates less false signals. it is achieved by means of the acceleration factor and the specific condition for the trend change that integral in this technical indicator.

To counterbalance the discreteness of the signals of the parabolic SAR there is an indicator as an oscillator built on the basis of a triple exponential moving average, smoothing price violent changes, TRIX:

$$TRIX_t = \frac{TMA_t - TMA_{t-1}}{TMA_{t-1}} * 100 \quad (5)$$

TMA is a triple moving average.

$$TMA = EMA(EMA(EMA))$$

The third indicator that will be used to measure the volume change is the volume oscillator. This indicator allows you to track the direction of the main trend in volume changes.

$$VO = EMA(volume, s) - EMA(volume, l), s < l \quad (6)$$

s is the period of «fast» moving average, *l* is the period of «slow» moving average.

When the «fast» moving average greater than the «slow» moving average, the indicator shows a tendency to increase the volume. If the «slow» moving average greater than the «fast» moving average, the indicator shows a tendency to decrease the volume.

Second set of indicators:

- Parabolic SAR
- TRIX
- Volume oscillator

1.3 Description of the set of steps and calculations of trading algorithm based on differences of technical indicators

Each iteration of the algorithm in input receives information about three securities for a certain period: price, volume and data of the selected indicators, with specified parameters. Next, a sequence of steps is performed:

1. For each security, we calculate the difference for each indicator for the period of time.
2. Calculation of the maximum number of compatible indicators (with the exception of the volume indicator). Indicators are considered compatible if their differences have the same sign.
3. Determination of the volume indicator signal, if the difference is positive, then the number of compatible indicators increases by one. Thus, an increase in the volume of transactions is a signal for a transaction, both for the sale or for the purchase of a security. Accordingly, a decrease in volume indicates the ambivalence of traders' opinions, and the indicator signals a high probability of mistake therefore the transaction should not be executed.
4. The number of compatible indicators is comparing to a specified critical value for which a decision is making to buy or sell a security.
5. Target the volume of the transaction is determining. At the first signal, the quantity of securities is determined by the corresponding zero value. When

the signal is saved, at each iteration, the volume increases by a given step. The volume is limited by the amount of available capital.

6. An application filing in QUIK to complete the transaction for each of the instruments. If the number of compatible indicators less than the critical value, then the application is not submitted.

Chapter 2. Realization and comparison of trading algorithms

To obtain practical results of the described trading algorithms, an application was developed in the scripting language Lua. The application works in parallel with the QUIK trading platform and has a minimum delay for receiving data. Iteration and, accordingly, decision-making is done in a neglectfully small time for the results of trading.

Indicator parameters, periods, and parameters are set inside the program. The interface of the developed application allows user to select the studied securities and indicators and to obtain information about the progress of the algorithm.

Code Securities:	Code Indicators:	SAR(%)	TRIX(%)	VolOsc(%)	STOP
SBER	SAR	-0.00722	-0.01197	-0.01085	00:23:55
LKOH	TRIX	-35.45502	-25.59493	0.04113	
GAZP	VolOsc	112.1329	42.90849	16.11768	
Iteration:		59			
In securities	0	0	0	0	
Cost of securities	0	0	0	0	
State	decreasing	decreasing	oscillating		
Total	1079160				
Profit	79160				
Free capital	1079160				
Loan	0				

Pic.2.1 App's interface

2.1 Selection of parameters for technical indicators that involve in trading algorithms

We use securities with the largest volume of transactions: Gazprom, Lukoil, Sberbank. This choice is due to the high liquidity of securities. High liquidity is the necessary condition for stable work of trading algorithms.

Chart data is taken for the 1-minute interval for a candlestick. For indicators, using standard parameters for which indicators are most effective on average:

- SAR
Step of acceleration factor $l = 0.02$, maximum of acceleration factor $m = 0.2$.
- TRIX
Number of periods is equal 9.
- Volume Oscillator
Short period $s = 5$, long period $l = 10$.
- AMA

Number of periods is equal 10.
«Quick» constant of average period $p=2$.
«Slow» constant of average period $q=30$.

- RSI

Number of periods is equal 14.

The initial capital is equal to 1,000,000 rubles. The size of a possible loan is equal to the amount of "free" money that not put up in the securities. The commission is set at 0.015% per transaction, which corresponds to the tariffs offered on the real market for traders with the capital more than a million. Credit rate is equal 0.038% per day.

2.2 Analysis and estimation of work based on examples using real data from the QUIK trading platform

We use the QUIK demo account to test the application. It was configured and the scripts of different versions of the application were connected to it. The experiments were conducted for different time periods. Algorithms were used taking into account the commission for a transaction and without this. Algorithms with making decisions for cases when all indicators are compatible and when 2 of 3 indicators are compatible.

Studied trading Algorithms were tested on data for 4 months: January-April 2020.

Due to the differences in the AMA and SAR indicators, the first algorithm indicates more signals about the detection of a probable entry point. On average, the first algorithm decides to complete a transaction 4 times more often. However, this leads to mistakes and the profit of the first algorithm is on average 20% lower than the second algorithm. The presence of a commission is also negatively combined with a large number of transactions that reduce the profit gap.

For the cost of a transaction in 0.15% of the transaction amount, the algorithms could not show a stable profit result. The second algorithm, on average, makes fewer false predictions in identifying entry points, but at the same time, it works with a large delay and misses some of the significant moments for the transactions.

Below there are plots for daily data.

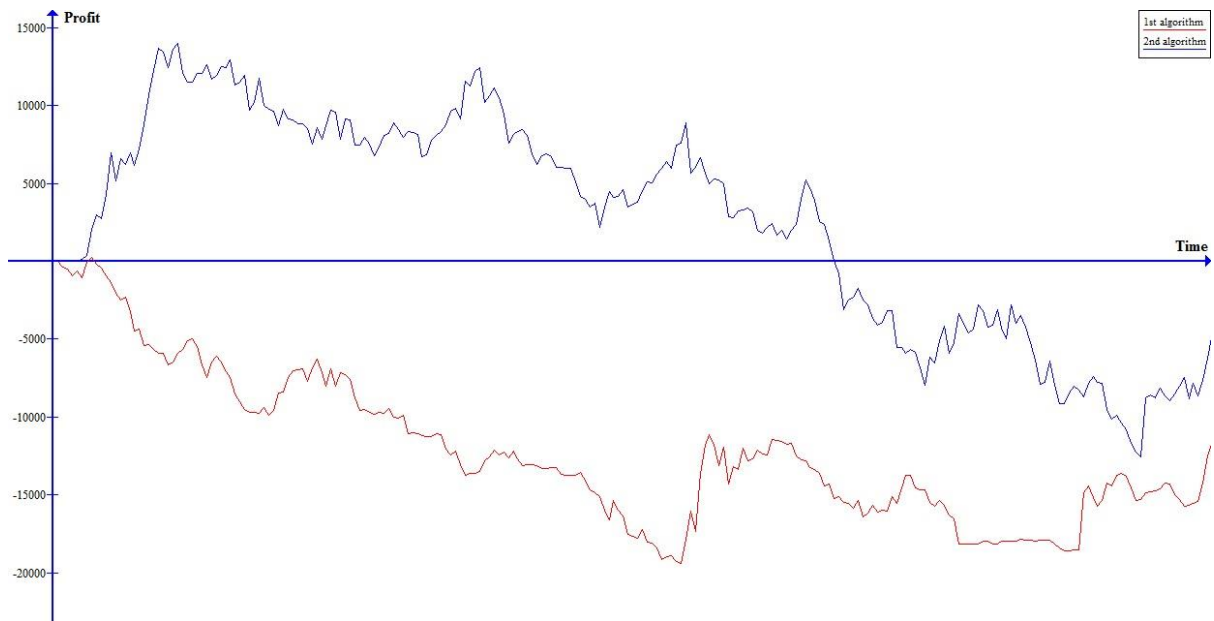


Fig.2.2 Algorithms with commission and full consolidation for the difference with 5-minutes time interval

For zero transaction costs, the results of the algorithms have a significantly smaller gap. The second algorithm shows an average profit of 0.1%, the first algorithm is unprofitable, -0.5% per day.

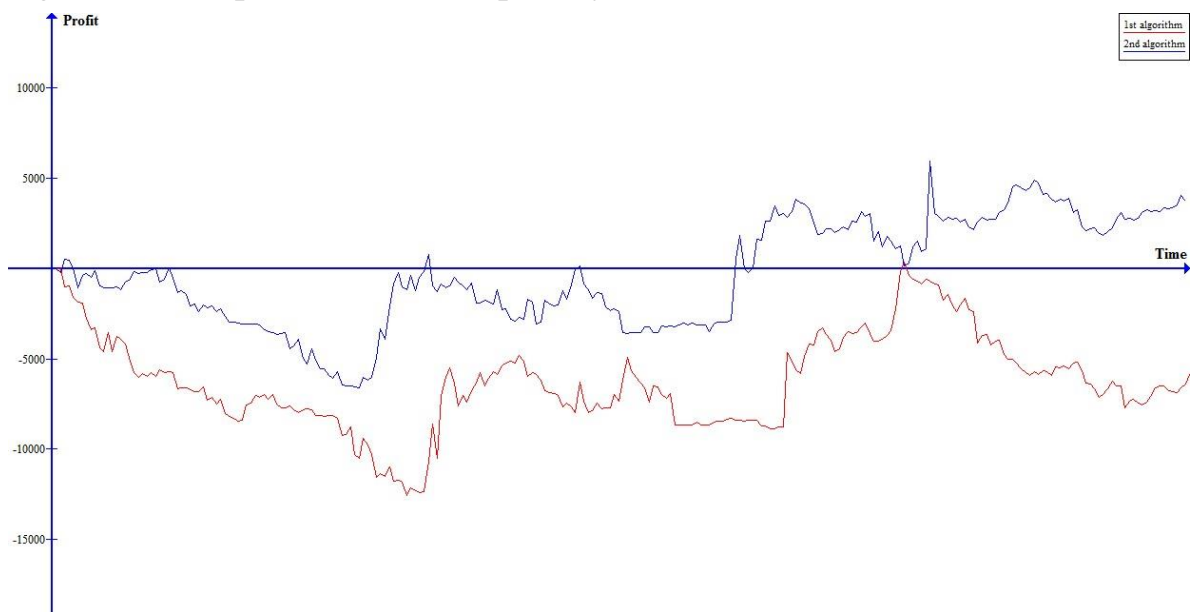


Fig.2.3 Algorithms with zero-commission and full consolidation for the difference with 5-minutes time interval

In most cases, decision-making based on the consolidation of all indicators reduces the probability of mistake.

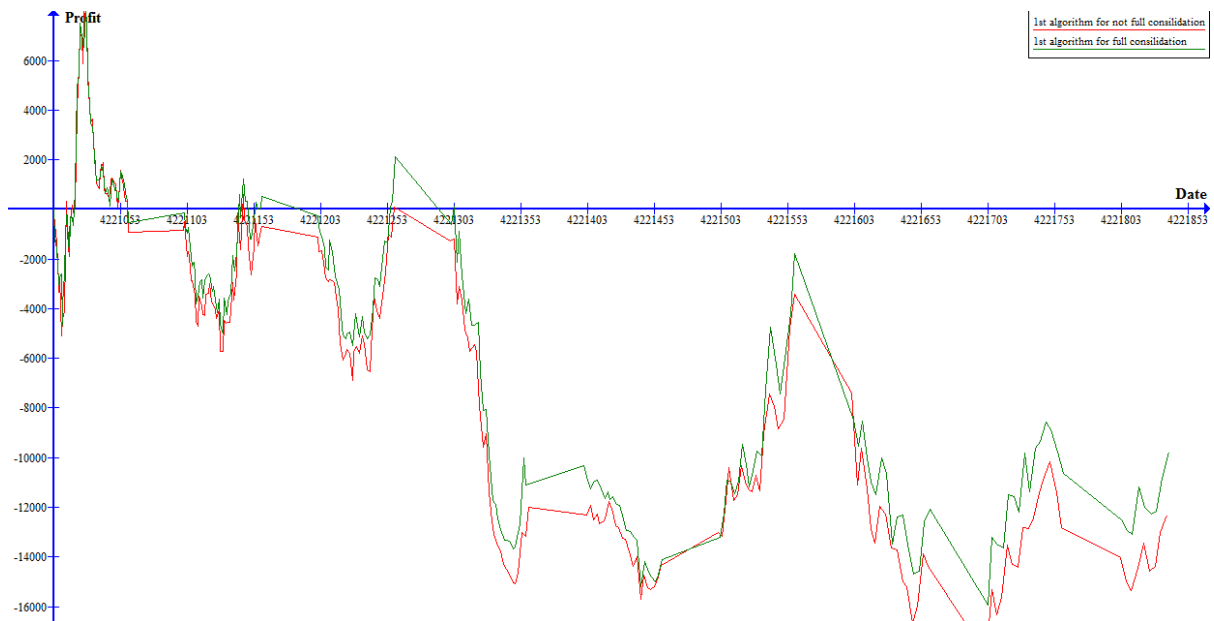


Fig.2.4 2nd algorithm with the commission, full and partial consolidation for the difference with 5-minutes time interval

The resulting algorithms are risky to use for autonomous trading it can result in losses. However, the results of a combination of indicators are much more effective than using the signals received for the isolated indicators. Trend indicators proved to be more effective than oscillators and volume indicators, but each algorithm based on only one of the indicators of two sets of technical indicators showed a negative result both for transactions with the commission and for zero-cost transactions. This result is associated with a large number of false signals generated by isolated indicators. At the same time, trend indicators are calculated for longer periods and are more independent.

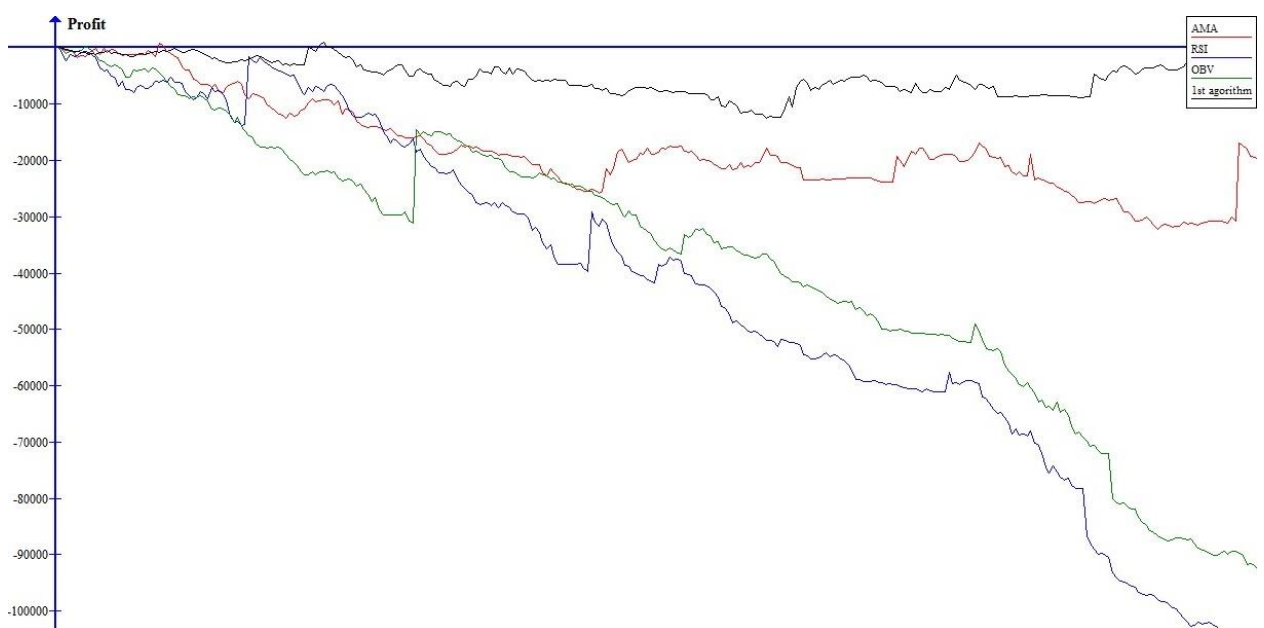


Fig.2.5 Isolated indicators of 1st algorithm with the commission for the difference with 5-minutes time interval

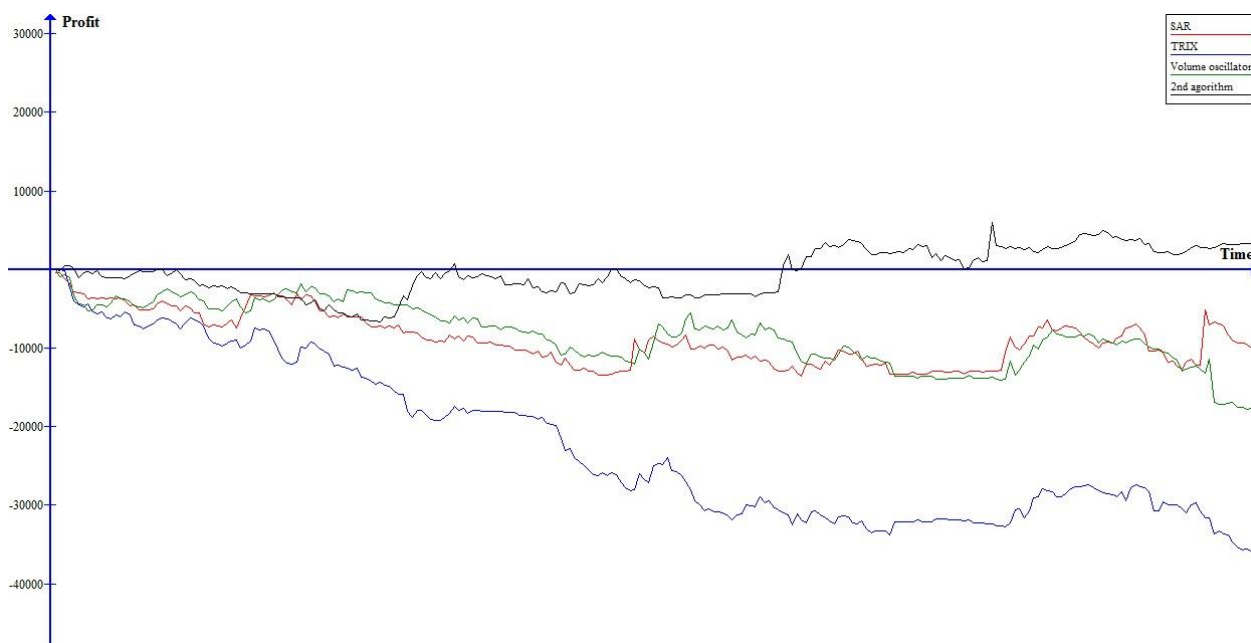


Fig.2.5 Isolated indicators of 2nd algorithm with the commission for the difference with 5-minutes time interval

Historical data:

Average daily profit for 1 day in percentage of full capital. 1st algorithm

Period for difference, min		Time interval, weeks		
		2	6	16
2	-0,0003%	-	-	-
5	0,0172%	-	-	-
15	0,0173%	-0,001%	-	-
30	0,0181%	0,009%	0,004%	0,004%
60	-0,0042%	0,062%	0,028%	0,028%

Table 2.1 Daily profits for 1st algorithm for zero-cost transactions

Average daily profit for 1 day in percentage of full capital. 2nd algorithm

Period for difference, min	Time interval, weeks		
	2	6	16
2	-0,005%	-	-
5	0,0161%	-	-
15	0,3611%	-0,007%	-
30	0,7832%	-0,019%	0,011%
60	0,9235%	0,064%	0,032%

Table 2.2 Daily profits for 2nd algorithm for zero-cost transactions

Empty cells caused by the time of storage for detailed historical data by the trading platform QUIK.

We can see a very high result for the 2nd algorithm for 2 weeks' work. But it is a low-significant result; the market was very unstable in these weeks and there are more significant results for larger time intervals.

2.3 Modifications of trading algorithms related to effects caused by trading on the online platform and various cases of the behavior of price changes for securities

The method of diversification can reduce the risk of the investment portfolio. Diversification of an investment subject is a method in which capital is invested in various securities, that reduces the risk of loss. Thus, a restriction has been established: for each security, it is possible to invest only a third of the total capital.

A time period of 5 minutes is effective for short-term trading; for longer trading time intervals and markets with stable trends, longer time periods may be more effective. The increasing of the period for which the difference is calculated allows reducing the risk, but at the same time reduces the potential profit, ignoring small fluctuations in prices.

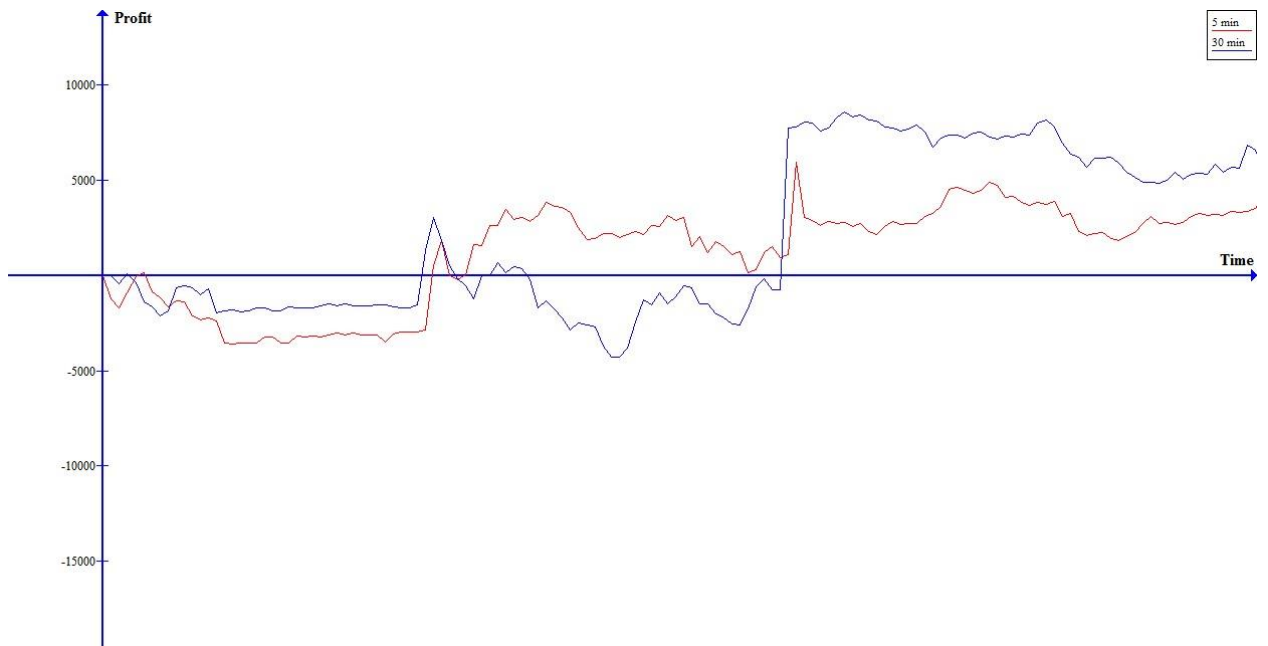


Fig.2.5 2nd algorithm with the commission for the difference with 5-minutes time interval and 30-minutes time interval

At the start of trading, a gap in prices is possible. Indicators are not able to track such gaps, the information for gap predictions relate to fundamental analysis and cannot be detected on a chart. However, indicators respond to price changes for gaps as a regular monotonous price movement and give a false and late signal about the trend. To avoid such cases, algorithms ignore strong price changes at the beginning of the trading day.

At the moment when there is no investment in security, a case of a downward trend is possible. In this case, it is possible to loan securities and, accordingly, sell them at this moment. For a loan, there is a limit of half the free capital for developed applications. At an entry point for an upward trend, the amount of securities in the amount of debt is bought, and then the algorithm continues to work in standard mode. The interest on the loan of securities is assigned from the beginning of each next day, therefore, in the last hour of trading, no loan is made, and the securities pay back not only with increasing but also with oscillation.

Conclusion

As a result of the investigation, two trading algorithms were obtained. The first is based on the adaptive moving average, the second based on the indicator Parabolic SAR that creates the support and resistance levels. The second algorithm proved to be more effective, it has greater profits and lower risks. The first algorithm, at the same time, can determine a larger number of possible points of trend changes.

The results of the algorithms depend on the stability of the market and are highly sensitive to transaction costs. Calibration of the period for which the values of differences are calculated can improve the efficiency effect of the algorithm in a corresponding market.

Autonomisation of trading algorithms based on a model for calculating indicator signals using a difference is risky in real trading activity on the QUIK platform, due to a large number of false signals. It is possible to use developed trading algorithms like an expert system that helps a trader to determine points for entering or exiting (purchase or sell) into securities trading.

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Appendix

Price and volume charts for selected securities for periods that used for examples.

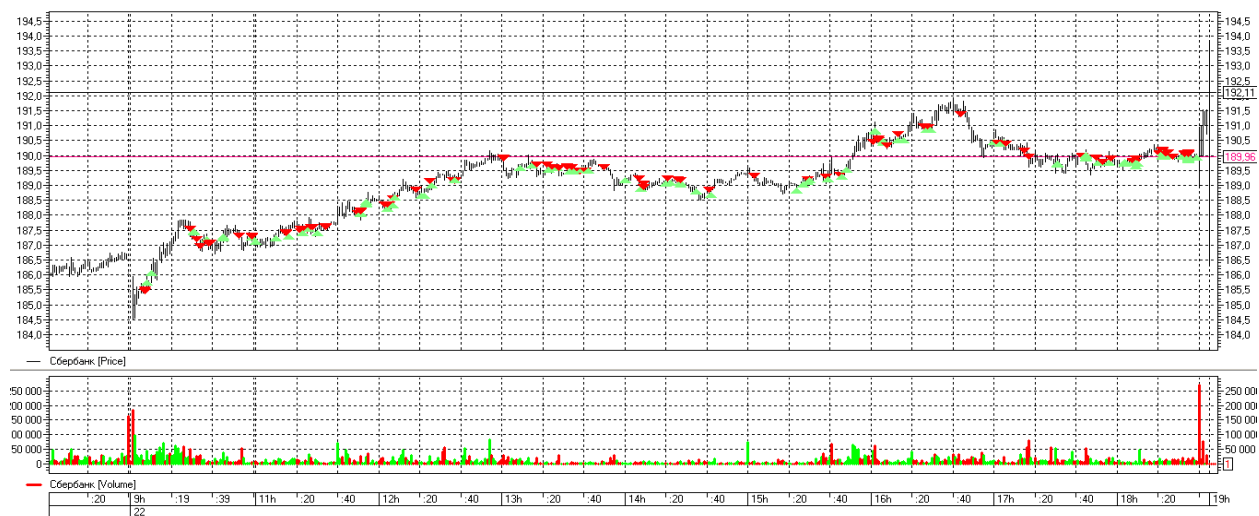


Рис.1 Sberbank 22.04.2020

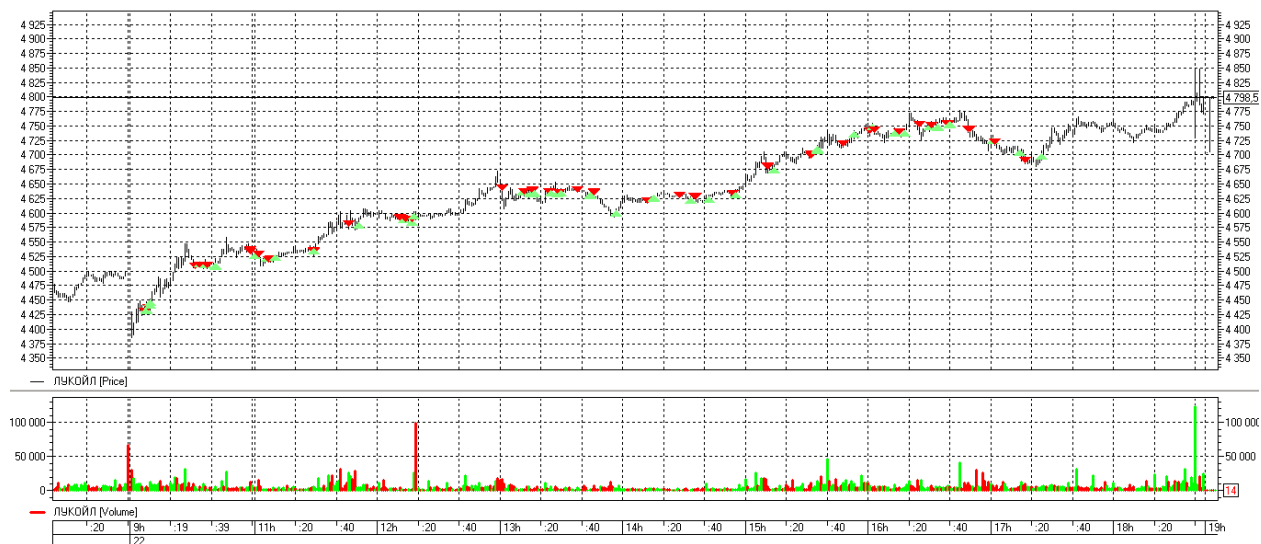


Рис.2 Lukoil 22.04.2020

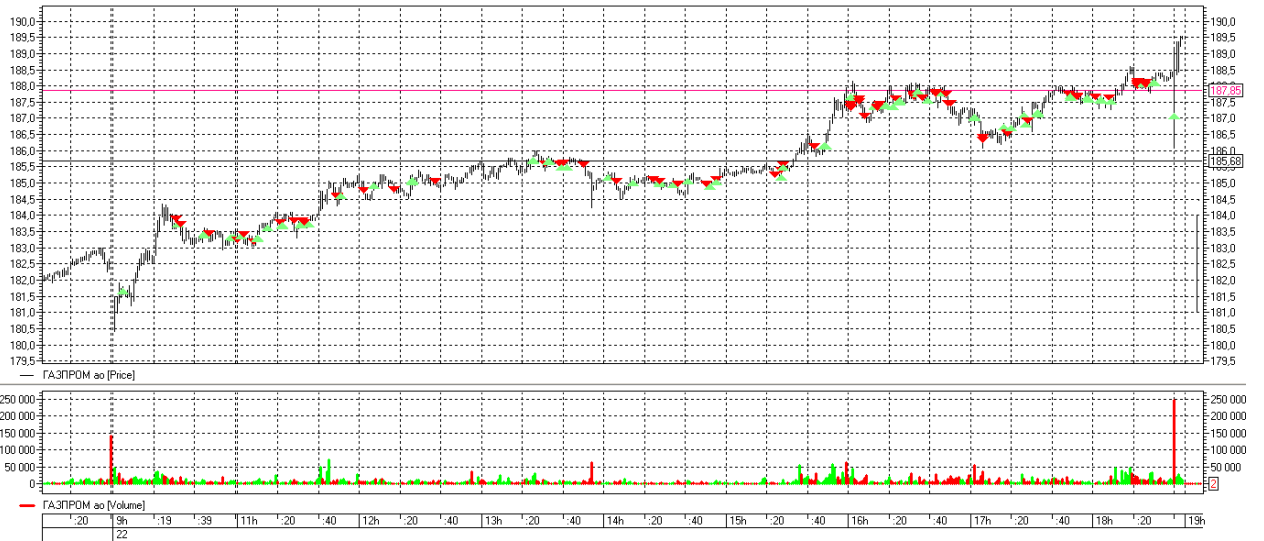


Рис.3 Gazprom 22.04.2020



Рис.4 Sberbank 15.01.2020 - 15.04.2020 (16 weeks)



Рис.5 Lukoil 15.01.2020 - 15.04.2020 (16 weeks)

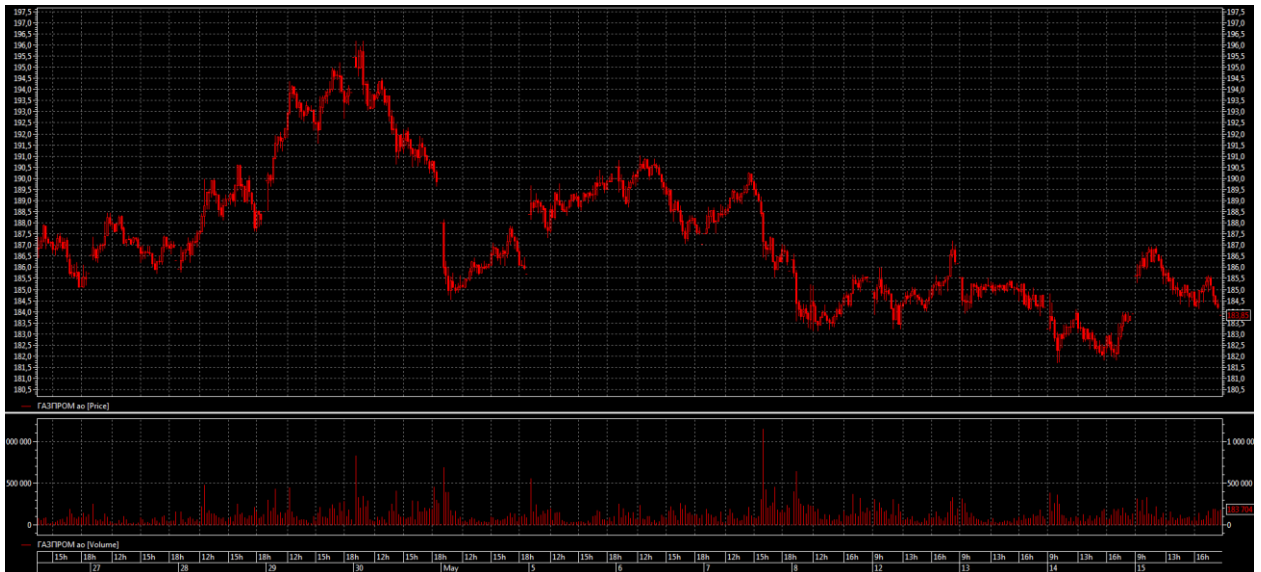


Рис.6 Gazprom 15.01.2020 - 15.04.2020 (16 weeks)

The function of the application where estimate trends of securities prices for the period (duration):

function analysis(numIndicators, numSecurities, duration)

```

local test_ds = {};
local legends = {};
local numCandles = {};
local tables = {};
local err = false;
local numIncreasingInd = {};
local resume = {};
for i = 1, numSecurities, 1 do
    if tag_SEC[SEC_CODE_FUT_FOR_OPEN[tr[i]]] == "TATN" then class =
"TQBR"; end; --tatneft
    if tag_SEC[SEC_CODE_FUT_FOR_OPEN[tr[i]]] == "SBER" then class =
"TQBR"; end; --sberbank
    if tag_SEC[SEC_CODE_FUT_FOR_OPEN[tr[i]]] == "LKOH" then class =
"TQBR"; end;
    test_ds[i], Error = CreateDataSource(class,
tag_SEC[SEC_CODE_FUT_FOR_OPEN[tr[i]]], INTERVAL_M15);
    --while (Error == "" or Error == nil) and (test_ds[i]:Size() == 0) do sleep(1) end;
    if ((Error ~= "") and (Error ~= nil)) or (test_ds[i]:Size() == 0) then

```

```

message("error for data of dataset №" ..i);
ToLog ("error for data of dataset №" ..toString(i));
err = true;
sleep(1000)
break;
end;
currentTime =
toString(test_ds[i]:T(timePoint).month)..".."toString(test_ds[i]:T(timePoint).day).."
".."toString(test_ds[i]:T(timePoint).hour)..":".."toString(test_ds[i]:T(timePoint).min);
legends[i] = { };
numCandles[i] = { };
tables[i] = { };
speedInd[i] = { };
numIncreasingInd[i] = 0;
for j = 1, numIndicators, 1 do
    volumeInd = 0;
    first_candle =
getNumCandles(tag_IND[SEC_CODE_IND_FOR_OPEN[tr[j]]].."_"..tag_SEC[SEC
_CODE_FUT_FOR_OPEN[tr[i]]]) - duration;
    tables[i][j], numCandles[i][j], legends[i][j] = getCandlesByIndex
(tag_IND[SEC_CODE_IND_FOR_OPEN[tr[j]]].."_"..tag_SEC[SEC_CODE_FUT_F
OR_OPEN[tr[i]]], 0, timePoint, duration);
    candlescandlesNotEq = false;
    speedInd[i][j] = (tables[i][j][duration - 1].low - tables[i][j][0].low) /
numCandles[i][j]; --numCandles[i][j] - 1
    speedInd[i][j] = (speedInd[i][j] / math.abs(tables[i][j][0].low)) * 100;
    speedInd[i][j] = speedInd[i][j] - speedInd[i][j] % 0.00001;
    if (tag_IND[SEC_CODE_IND_FOR_OPEN[tr[j]]] == "Volume") or
(tag_IND[SEC_CODE_IND_FOR_OPEN[tr[j]]] == "Chaikin") or
(tag_IND[SEC_CODE_IND_FOR_OPEN[tr[j]]] == "VolOsc") then
        if speedInd[i][j] > 0 then volumeInd = 1;
        elseif speedInd[i][j] < 0 then volumeInd = -1;
    end;
else
    if (tag_IND[SEC_CODE_IND_FOR_OPEN[tr[j]]] == "SAR") then

```

```

    table, numCandle, legend = getCandlesByIndex
("Price".."_"..tag_SEC[SEC_CODE_FUT_FOR_OPEN[tr[i]]], 0, timePoint, 1);
    price[i] = table[0].close;
    if (((speedInd[i][j] < 0) and (tables[i][j][duration - 1].close < price[i])) or
(tables[i][j][duration - 1].close > price[i]) and (speedInd[i][j] > 0)) then
        speedInd[i][j] = speedInd[i][j] * -1;
    end;
end;

if speedInd[i][j] > 0 then
    numIncreasingInd[i] = numIncreasingInd[i] + 1;
end;
if speedInd[i][j] < 0 then
    numIncreasingInd[i] = numIncreasingInd[i]- 1;
end;
end;
end
if numIncreasingInd[i] + volumeInd >= numIndicators then resume[i] =
"increasing";
elseif numIncreasingInd[i] - volumeInd <= -(numIndicators) then resume[i] =
"decreasing" ;
else resume[i] = "oscillating";
end;
end;
--message('Analysis report: numIncreasingInd = '..numIncreasingInd..' speed1 =
'..speedInd[1]..' speed2 = '..speedInd[2]..' speedVolume = '..speedInd[3]);
if err == false then
    info2(speedInd);
end;
return resume;
end

```