Using Transport Analogies in OFZ Market-Making

Petr P. Bobrik[*]

Solomenko Institute of Transport Problems of the Russian Academy of Sciences, Saint-Petersburg 199178,. Russia
[*]Corresponding author. E-mail: Bobrikpp@mail.ru.

ABSTRACT

The article describes the methodology for conducting market-making operations (later MM, the market-maker will also be designated) of Russian government debt securities on the Moscow stock exchange, used in the investment company Univer Capital during 2018-2020. The methodology uses a number of analogies with classical transport problems, where individual papers are considered as points of departure and destination of goods, and the search for an optimal transportation plan is based on the current attractiveness of nodal prices in the network. The methodology allows at any time to calculate the desired portfolio of Federal Loan Obligations (later QFZ) and place orders that satisfy the requirements of MM.
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1. INTRODUCTION

Traditionally, fixed-income financial instruments are among the most liquid and traded in the world. [1]. Futures on US 10 notes and 30 year bonds, along with futures on Eurodollar, have the highest trading volumes among all exchange-traded futures in the world. In other countries, the liquidity of government debt securities substantially depends on the development and capitalization of the national debt market. But regardless of trading intensity, usually sovereign debt securities are among the most recognizable national instruments among global investors.

Although there are no particular problems with circulation in liquid assets, from the beginning of the issue of bonds of the Russian federal loan and until now, the liquidity of the OFZ market has been poor. [2]. At least this opinion is dominant in the Russian central bank and the management of the Moscow stock exchange.

This is especially evident during the aggravation of political disagreements with Western countries, when there is a rapid outflow of foreign funds from national markets, sometimes leading even to empty orders books on individual papers. Such a situation negatively affects the attractiveness of Russian borrowing. This leads to significant losses of both financial and reputation plan.

To increase liquidity and narrow price spreads in exchange orders books, the Moscow Exchange has been implementing market-making programs for a number of government debt securities for many years. Various financial institutions can take part in these programs, which for a number of preferences are ready to quote and make transactions with OFZ securities at their own expense. This practice is quite common on exchanges around the world.

2. FEATURES OF THE MAKKET-MAKING PROGRAMS OF THE MOSCOW EXCHANGE

There are three MM OFZ programs on the Moscow Exchange. Full descriptions of the parameters are publicly available on the exchange website. [3]. We list their most important features.

MM is obliged to maintain bilateral quotes with a spread determined by the exchange for 5 hours 45 minutes from an 8-45 day trading session. At the time of writing, the value of orders must be at least 3 million rubles.

The composition and number of securities of MM programs are not constant. As some OFZs expire, they are replaced by others; sometimes, paper is added or deleted for specific reasons. In general, in recent years, about 25 securities representing the entire Russian yield curve (hereinafter referred to as YC) have simultaneously participated in the liquidity maintenance program.

There are no special difficult requirements for participation in the programs. The attractiveness and profitability of such an activity for potential participants comes to the fore here.

An important feature of the programs is the absence of penalties in the event that MM does not fulfill its obligations. In this case, he is considered as an ordinary trader, without terminating the contract, but without exchange fees. Although this causes reasonable discontent on the part of the exchange, at present, de facto MM is voluntary. This is largely due to the presence of high by global standards risks when quoting Russian securities. Perhaps in the near future, the trading regime will become more mandatory.

The main bonus of the exchange for participants in MM programs is the payment of their rewards. Payments occur once a month. They consist of three parts: compensation of the exchange commission for passive (executed on participant's limit orders) transactions plus remuneration

proportional to the total volume of passive transactions and plus a fixed payment for each security for the day that the exchange's requirements for maintaining quotes were met. Throughout the study period, specific coefficients of the final remuneration formula changed depending on the situation on world markets and the current exchange policy. This led to different priorities when choosing trading strategies.

At the time of writing, the fixed portion of the fee is negligible. Therefore, for the profitability of operations, first of all, it is necessary to strive to carry out the largest volume of transactions. This is the main feature of MM in federal loan bonds, which made us creatively refer to the classical methods of portfolio investment, where the achievement of the highest profitability for each transaction is usually based on. [4].

3. YIELD CURVE

The most popular method of medium-term investment in the fixed-income segment is to compare the current yield of a particular paper with the current market YC. If the yield is below the curve, then it is considered overvalued. And underestimated otherwise. In particular, for MM, this means that quotation support orders must be located on both sides of the yield curve.

Moreover, changing the shape of the curve itself is considered a less dynamic process than the pricing of securities, and therefore is taken into account secondarily. Investing based on forecasts of the dynamics of YC is a separate class of trading strategies, and they will not be considered further in the article.

The main difficulty with this investment approach is the concept of YC, which is some purely theoretical idealization, since in reality there is only a certain set of securities with specific returns that need to be somehow connected into a single curve, which can be done in different ways. However, from the point of view of MM, different YCs mean different quotation prices, up to replacing buy orders with a sell order and vice versa. In other words, for the correct assignment of MM, it is necessary to strictly determine what is meant by YC.

Build YC can be done in different ways, depending on the objectives of the study. At the beginning of trading, while debugging the MM methodology, old practices were used to construct a similar curve for option implied volatility [5], which has been successfully used for many years in various trading robots that actually work on the exchange. Similar curves that were made publicly available by the Moscow stock exchange were also considered. [6].

Unfortunately, although the classical approach based on YC, although it turned out to be workable and, on the whole, quite adequate, it was necessary to abandon it after a while. The reason for this was the peculiarities of the exchange requirements for MM participants, the execution of which was obtained only by reducing the profitability of operations up to unprofitable results.

Classic MM on bonds, as a rule, has its own significant portfolio of securities. [7]. Fluctuations in supply and demand on the part of the market are satisfied by either increasing or decreasing the portfolio. [8]. At the same time, the condition must surely be fulfilled that in quantitative terms these changes would be insignificant, in comparison with the portfolio itself. In this case, the overall profitability of asset management was primarily determined by the quality of investing in the portfolio, and income from MM was an addition.

However, in recent months, OFZ yields have become lower than many alternative yields due to their highest reliability. Under these conditions, such an approach could not guarantee market profitability. Because of this, many investors (primarily with not very high net capitals) did not become satisfied with considerations of the highest reliability of OFZs, requiring a complete termination of operations with these classes of financial instruments. Additional cash support from MM programs has become insufficient.

The unprofitability and therefore the inability to attract large capital to ensure the operational activities of MM also led to a very unpleasant consequence in the form of the requirement to maximize the reduction of balances in securities at the end of the day, which essentially turned into intraday trading. [9] This is not at all characteristic of this type of securities, where bonds are often held on the balance sheet of the portfolio for years until they are fully redeemed.

The requirement to minimize overnight balances also made it impossible to invest based on comparisons with YC. As practice has shown, significant deviations from securities from their "fair" value can last for weeks, preventing the possibility of exit from the transaction at the end of the day.

The last factor that required the development of a fundamentally different trading methodology was the special structure of the exchange's remuneration, where the emphasis was on the growth in the turnover of passive transactions. Increasing trading volumes on paper is extremely useful for the attractiveness of trading, and is one of the goals of any MM. But this feature required transactions with moderate and sometimes even zero profitability, which often contradicts classical approaches to investing.

4. TRANSPORT ANALOGIES

The basis of the new MM methodology on the OFZ market was the presentation of traded securities in the form of a certain transportation network with nodes x_i, $i = 1, ..., N$.

Each item is connected to those items that represent papers with close durations. Thus, the OFZ portfolio is defined by a mathematical graph with N vertices, as is usually the case in transport problems. [10].

For each edge of the graph, its length is determined, determining the distance between neighboring nodes. It is equal to the average differences in the yield of securities for a certain period of time.

$$l_{ij} = mean\left(\left|d_i, d_j\right|\right)$$

Here l_{ij} - the distance between the vertices of the graph,

d_i - is the current yield of the i-th paper.

Each point has an independent exchange-type pricing. [11]. Changes in yields in securities neighboring to duration have an effect on the pricing process, similar to the mutual influence of prices in neighboring nodes of the network. With strong deviations of returns in the transport network, preconditions arise for arbitration with the simultaneous sale of low-yield paper and the purchase of high-yield. From the point of view of transport analogy, this means the delivery of goods from a point with low prices to a point in with high prices. [12]. Thus, the general network pricing is correctly determined in the graph.

At each decision point, the graph considered the optimal transportation plan using linear programming methods. On the basis of which the characteristics of MM orders were determined.

The article involves the approach of network exchange pricing, which involves the reduction of all prices from various market participants from different nodes into a single table of orders in each network node. MM offers an active stream of orders both from the side of purchase and from the side of sale.

In the case of a continuous representation of the dynamics of the system, we will assume that the pricing at each node of the graph is described by a differential equation. [8].

$$p' = \frac{\rho_{bid}\, v_{bid} - \rho_{ask}\, v_{ask}}{\rho_{bid} + \rho_{ask}}$$

Here p - is the asset price, ρ - is the density of orders, v - is the speed of advancement of applications, "bid" is a buy order, "ask" is a sell order.

The order flow parameters are selected depending on the current paper tailings, the attractiveness of each paper compared to its neighbors, risk management considerations and the general current situation in the financial markets in the world.

Unlike other variables for which strict calculation rules exist, taking into account the general current situation in the world is not strictly formalized. It is selected by the trader based on the recommendations of analysts, as well as on the basis of more long-term trading strategies based on trending considerations. [9]. Long-term trends rarely change within the trading session, so this parameter is constant in most cases. It differs from zero only in the case of some special events in the markets, which is not often the case. Therefore, this parameter is practically not involved in pricing and most of the time does not affect operations.

5. TRADING RECORDS

Real operations on the Moscow stock exchange under MM programs began in the 4th quarter of 2018. In view of the initial debugging of the trading strategy, its characteristics have become relatively stable only since the beginning of 2019. The total trading results for the past year are presented in the diagram.
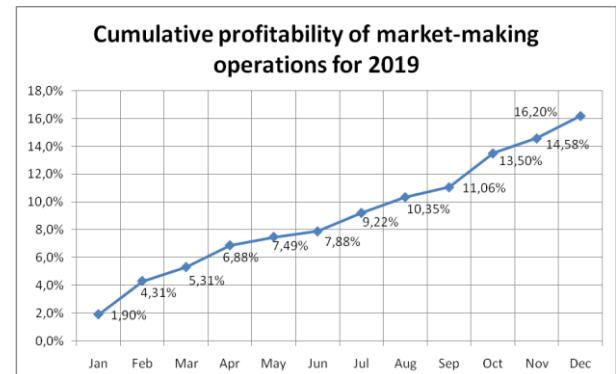

Figure 1 (a) Profitability from MM operations significantly outperformed the average profitability of federal loan bonds and the risk-free rate of the Russian Central Bank.

In the chart, profitability was considered as a simple sum of monthly returns. That is, the result is shown less than what could be imagined taking into account complex interest.

Despite quite strong fluctuations in OFZ quotes during the year, the result of each month was positive, and averaged slightly less than 1.5%. Actual rates for attracting cash resources that serve as collateral for operations varied during the trading period from 8.5% to 6.5% percent. With these deductions taken into account, the net profit from operations for the year, calculated as the sum of monthly transactions, remained positive and amounted to about 7.85%.

Taking into account global trends in falling returns on fixed-income instruments down to negative values, one can expect a further fall in OFZ rates in the coming years towards the returns of developed countries. [13]. Under these conditions, a general problem arises of maintaining the return on investment. Carrying out operations according to the proposed method allows to partially solve this problem. [14].

6. CONCLUSION

- A methodology for participation in MM programs in the OFZ market was developed, based on analogies with transport tasks.
- According to the proposed method, trading were held on the Moscow stock exchange.
- The total profitability of operations for 2019 was 16.2%.
- Profitability for 2019 exceeded the average profitability in this sector by more than two times.

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