The Management of Investment Portfolios

Maria Yevgenyevna Konovalova, Olga Yuryevna Kuzmina,
Alexander Mikhaylovich Mikhaylov, Larisa Vladimirovna Levchenko,
Svetlana Yuryevna Salomatina

Samara State University of Economics, 141 Soviet Army street, 443090, Samara, Russia

Abstract **– The strategy for the Russian financial market management for the period up to 2020 aims at increasing the volume of money resources directed to the real sector of economy. The study aims to update mathematical methods and criteria for assessing investment decisions applicable to the development of practical recommendations for the functioning of Mutual funds and rising management companies' attractiveness. The study bases on the system approach and application of the Value at Risk (VaR) method and covers 2010-2017. The necessity of using economic and mathematical modelling in the analysis and selection of the most optimal investment portfolio is proved.**

Keywords **– Mutual fund, economic and mathematical modelling, investment portfolio management, securities, Markowitz theory.**

1. Introduction

One of the most important parts of the plan for sustainable development of the Russian economy is the formation and maintenance of a full-fledged financial market functioning. The main direction of the work to achieve this goal is to solve the problem of lack of cash flow from individuals, which, in turn, raises the question of the development of a collective investment system, as one of the possible prospects of addressing the difficulties. At this stage, monetary assets in the form of savings in the hands of the population reach very high values. Most of these assets are placed on bank deposits, the yield of which does not even cover real inflation.

Collective investment institutions are underdeveloped, which prevents the population from investing their money in alternative investment instruments.

The formation of collective investment institutions, including the development of the mutual fund (MF) market, will create conditions in which the savings of the population are not "eaten up" by inflation, and successful companies will receive funding sources.

The development of the mutual fund market will help to attract domestic investment in the national economy and will create prerequisites for economic growth, which will lead to an increase in tax revenues, and hence government spending on social programs, salaries of public sector employees. Besides, the development of the market will increase competition among potential investors for the money of the population and will increase the liquidity of the financial market as a whole.

In advanced economies, various investment funds play a leading role among investment institutions providing a more risky but more profitable alternative to investing in bank deposits.

At the moment, the authorities' efforts to attract capital to the Russian economy are visible. The regulation and transparency of the financial market are increasing, which reduces the risks for investors, so we can also talk about the development of the collective investment market, as an institution for the accumulation of the population's free cash.

In addition, for the population the issue of preserving the value of their savings is also becoming relevant since the devaluation of the ruble in 2013-2014 led to the deterioration of the quality of life of the citizens, while the financial market could have been protected against fluctuations in the exchange rate of the national currency. Another problem of the domestic financial market is the low liquidity of the collective investment market. It is also possible to single out the lack of formation of the Russian

DOI: 10.18421/TEM83-34
https://dx.doi.org/10.18421/TEM83-34

Corresponding author: Maria Yevgenyevna Konovalova,
Samara State University of Economics, Samara, Russia
Email: *konovalova-mariaa@rambler.ru*

Received: 07 March 2019.
Revised: 15 June 2019.
Accepted: 10 July 2019.
Published: 28 August 2019.

securities market and rather low qualification of the most part of professional participants.

The above circumstances determine the relevance and prove the practical significance of the study topic.

In the context of unstable and volatile stock markets that have developed in Russia today, traditional instruments of diversification of investments may not always be applicable in practice. Hence, it is necessary to search for new, including economic and mathematical, methods for financial management and modeling of investment portfolios.

To solve this problem, the study purpose was formulated – updating mathematical methods and criteria for assessing investment decisions applicable to the development of practical recommendations for the functioning of mutual funds in modern Russian conditions.

Research questions: what are efficiency criteria for the investment portfolio of an MF; specific features of investment strategies of MFs and methods of their assessment (by the example of the largest Russian MFs); the role of economic and mathematical modeling in the evaluation of the optimal investment portfolio of MF?

2. Literature review

Some researchers refer to "collective investment" activities in the open market to invest the financial resources of companies and individuals in various securities for profit [1]. Others define it as a mechanism by which private investors voluntarily transfer money or assets to the management of professional players for subsequent profitable investment in securities and other property [2].

A professional market participant is necessary because a private investor usually does not have experience and time to invest, and the size of his assets is not large enough to build a portfolio with low risk and acceptable expected return, which can lead to losses by independent private investors. When a large number of interested individuals join together, the barrier of high requirements to the volume of investments falls to optimize the problem of the investment risk-return ratio. Such an opportunity is provided by funds engaged in collective investment.

The history of such associations dates back to Belgium in 1822, and then their heyday occurred in England and the United States at the end of the nineteenth century.

The development of mutual funds in our country began in the 1990s, when for the first time since the time of the USSR, the opportunity to invest money in stocks of investment funds that were reinvesting these funds in the open market was formally fixed.

Since the first funds were registered in 1996, their number was growing exponentially. The rapid growth in the number of registered funds stopped during the crisis of 2008, but up to 2013-2014 there was still a positive trend of dynamics. With the change in the policy of the Central Bank in 2013 consisting in the purging of financial markets from unreliable participants, there is a tendency to a reduction in the number of registered funds, which continues to the present (Figure 1.).

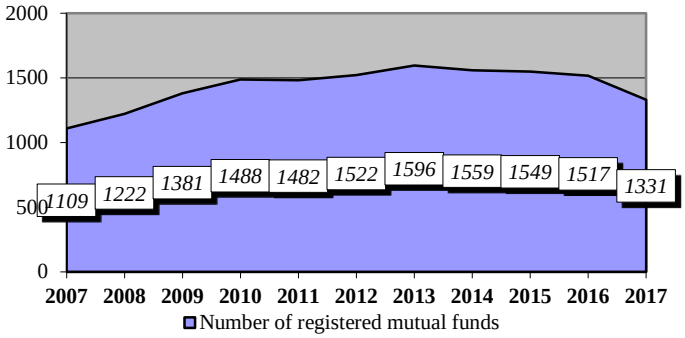

Figure 1. Dynamics in the number of registered mutual funds in the Russian Federation [3].

In the law "On Investment Funds" dated November 29, 2001 No. 156-FZ, activities of mutual funds are defined as the relations connected with attraction of money and other property by the placement of stocks or the conclusion of trust management contracts for the purpose of their association and the subsequent investment in objects, as well as with management (trust management) of investment funds' property, accounting, storage of investment funds' property and control over disposal of the specified property.

An investment fund interacts with depositors on the basis of the following relationships:

- an investment fund may raise funds from several interested parties;
- all investors' funds are combined into a fund that is transferred to the management of a professional manager;
- the manager invests the resources of the fund in accordance with the objectives of ensuring the achievement of minimum risk while ensuring the required return on investment achieved through diversification of investments.

At the same time, it should be borne in mind that the money invested in the fund is not the property of the management company, which protects the rights of depositors' interests against the misconduct of the management company. This gives confidence that investments will not suffer from various illegal manipulations.

The following financial assets [4]: securities, cash in various currencies, derivatives (derivative financial instruments), precious stones and metals can serve as objects of investment of the fund's assets.

Funds are classified according to the investment object: stock fund; bond fund; commingled fund; private equity funds; venture funds; fund of funds; annuity fund; real estate fund; mortgage fund; index fund (indicating the index); credit fund; commodity market fund; hedge fund; fund of artistic values; long-term direct investment fund.

Each type of a fund by time complies with its own set of possible types of funds by the investment object. This classification is based on strategies that fund managers can use, which leads to a certain risk-expected return ratio. The essence of activities of mutual funds from an economic point of view and the peculiarities of their functioning have been well studied in the works of foreign scientists, which is explained by the relevance and wide spread of this type of collective investment in Western countries. Thus, American economists Sharpe, Sortino and Treynor derived coefficients to assess the effectiveness of managing the investment portfolio or a mutual fund [5, 6, 7]. It should be noted that these authors in their works examine the issues of forming the investment portfolio using solely stocks and bonds. As a result, their developments to optimize investment portfolios are not always applicable to the mutual funds market, since they do not take into account the specifics of the collective investment market.

The main advantage of portfolio investment is the possibility to choose a portfolio that fully meets its originator' needs, depending on the purpose of investment. For this, different approaches are used to formulate a strategy, each of which provides a certain level of profitability and risk of investments [8].

An effective portfolio is a set of financial instruments in the portfolio, in which the required expected return is achieved with a minimum level of riskiness of operations.

In assessing the effectiveness of management, it is impossible to use a single specific criterion, such as profitability, since investments in various types of funds bear various types of risks [9]. When investing in an open-end bond fund, it should be borne in mind that its yield may differ by several times from investments in closed-end venture funds, since their risks are not comparable.

Each type of fund strategy must comply with certain optimal values of the efficiency criterion [2]. It follows that for each specific strategy there is a group of criteria that can objectively reflect the effectiveness of management in terms of the restrictions that are imposed on the investment process in accordance with the rules of the fund and other regulatory legal acts taking into account the overall economic situation in the market.

When assessing the effectiveness of investment activities of fund managers, two groups of indicators can be distinguished: quantitative and qualitative [10]. These include:

- Performance;
- Economic feasibility;
- Adaptability of the strategy;
- Rapid actions of managers;
- Riskiness of investments, their reliability.

Of special note is the importance of true reflection of the management processes in dynamics, the absence of contradictions between the indicators.

Investors who invest in the fund should be able to fully analyze the information on how the assets of the fund are managed, what are the results of the fund's activities, how much they deviate from the expected indicators. Knowledge of this information can be used by investors to make a decision to expand or reduce the top manager's capabilities, his/her remuneration, the amount of funds at the disposal of a particular fund.

The essence of assessing the management efficiency of the fund's investment portfolio is that it can in some way affect the way managers honor the interests of their clients, which will help to decide on further investment in the fund, or the withdrawal of assets from the manager's order [2].

According to Sharpe, although the assessment of management effectiveness is the last step in the portfolio management process, it can also be seen as part of an ongoing process [5]. Moreover, it can be called feedback or a control mechanism that can make the management process more efficient [11].

It is also important to compare the dynamics of the effectiveness of management decisions, as the effectiveness in the past may be just a fortuitous turn of events for managers.

Low efficiency is often caused by the following factors:

- Unfavorable market conditions;
- Excessive volume of transactions performed by the fund manager;
- Manager's too high remuneration or his/her low qualification.

A mutual fund is essentially an ordinary portfolio, from which an investor expects a certain return, level of risk and liquidity of assets. The MFs do not relieve the investor of investment risks. The fund manager should take into account the preferences of depositors acting only within the framework established by the rules of the fund, as well as use basic management strategies.

The efficiency of management of mutual funds may be characterized by an increase in the yield, the value of the share, the level of reliability of investments, the size of the fund's net assets and the level of liquidity of the shares [12].

It is impossible to develop a single system of recommendations for the selection of a fund, as private investors have different preferences. Many investors view investments in mutual funds as pension savings, because for a fairly long investment period one can accumulate quite a serious amount [13]. Legal entities can invest in mutual funds for optimizing taxes, additional income from temporarily free money, diversification of their risks through an additional type of activity – investment.

For example, stock funds in the long run produce more profitability than bond funds that can act as an alternative to bank deposits, but their profitability is more predictable and calculated. The yields of different types of funds vary considerably (Table 1.).

Table 1. Comparison of the average weighted yields of various types of funds for the period of January 2016 – January 2017 according to the National League of Management Companies [3].

Category	Open-end	Interval	Closed-end
Stock funds	34.89%	29.92%	14.76%
Bond funds	7.33%	*	*
Blend funds	11.58%	18.77%	17.97%
Money market funds	9.51%	*	*
Index funds	50.25%	*	*
Funds of funds	-12.10%	*	*

Note: * – *There are no formed funds of the given category and type.*

The peculiarity of forming the portfolio of institutional investors is that they have quite significant amounts of money at their disposal, so they need diversification. Besides, often such investors have legal restrictions on investing in a particular asset. This predetermines the need to implement a certain investment strategy, the choice of which is often a mixture of investor's subjective assessments and judgments about financial assets and objective assessments regarding investments [14].

One of the investor's fundamental decisions regarding the strategy is the choice of passive or active investment. The hypothesis of market efficiency suggests that passive investment is more profitable than the active one in the long term, since active investment is impossible without additional transaction costs.

Having chosen a certain investment strategy, the subject determines those MFs that meet his expectations:

1) bond funds that are conservative, since they have a standard low yield;

2) stock funds, where profitability and risks can be both low and one of the highest, depending on the strategy of the fund manager;

3) commingled funds;

4) money market funds specializing in short-term investments in deposits, currency and bonds [11].

Different types of funds allow satisfying the most various inquiries of investors from the most conservative to highly aggressive investment strategies.

The current theory of market efficiency is the basis for modern investment. Market participants who believe that this theory is true rely on the following postulates [15]:

- The absence of information asymmetry;
- Taking into account all existing facts about the issuer in the asset price;
- Lack of opportunity for arbitrage strategies;
- The existence and observance of fundamental economic laws in force in the market;
- Availability of laws in the market and their repetition.

An important condition for the effectiveness of portfolio investments is the efficiency of markets, without which the presence of stochastic (probabilistic) patterns underlying all calculations of portfolio metric is questioned, i.e. there are no analogies between past and future events and the price of financial assets is subject only to completely random changes [16].

The theory of Markowitz, who was the first to put forward an idea of how to formally and mathematically express the degree of risk of an asset through the statistics of the standard deviation, still lies in the very essence of portfolio investment despite the existing shortcomings [17].

In fact, by calculating the standard deviation instead of the degree of risk, one can obtain volatility metric, which is quite closely related to the notion of risk, but is not identical to it. Unlike risk, volatility implies variability, the possibility of changing the characteristics of the observed phenomenon in one side or another [18]. With regard to financial markets, it cannot be said that an unforeseen or excessive change in the value of an asset with a long position is a risk to the investor.

Russian market is currently far from an effective model due to the high degree of information asymmetry for market participants, imperfection of the institutional environment and deficit of funding.

Thus, the existing approaches to assessing the effectiveness of MF management can be divided into three groups:

1) Basic approach – based on the study of absolute indicators and the use of comparative analysis with reference values;

2) Coefficient approaches – based on the calculation of relative indicators (coefficients) of efficiency in the mutual funds management;

3) Specialized techniques – involve the development of independent approaches and methods.

The authors adhere to the third approach.

3. Materials and methods

Numerous problems of coefficient analysis revealed by the authors in the course of the study predetermined the use of the Value at Risk (VaR) method in the work, which was used because of its following properties:

- shows the immediate possible losses in conjunction with their probability, which facilitates the interpretation of the results;
- allows determining the risks under different conditions using a universal indicator;
- is easily aggregated when calculating the portfolio risk (in fact, it is necessary to know the values of VaR for each of the assets and their weights in the portfolio).

Moreover, the advantage of the VaR calculation method is its simplicity, which does not require large computing power.

In essence, the methods for determining VaR are to find the quantile of ranked aggregate data, which implies that VaR depends on the following characteristics:

- The method of determination. With a sufficiently large set of observations, historical modeling should be used, since the rigid determination of the distribution form usually does not lead to a good degree of approximation of the sample random variable to the value of statistics of the entire population, especially given the problems with parametric approaches.
- The degree of reliability, in other words, the likelihood of negative consequences;
- The data period. As the prediction time horizon increases, the VaR value also increases.

The methodological basis of the study is the system approach that considers a mutual fund as a tool for the formation of the investment portfolio and as an element of collective investment characterized by certain organizational and financial features, the consistency and the depth of studying the problems of the Russian market for collective investment, which allowed developing and justifying practical recommendations aimed at developing mutual funds in the Russian Federation.

Limitations: The instability (volatility) of equity markets the use of mathematical methods and models does not always mean a guaranteed result. However, despite this limitation, optimization models of the investment portfolio structure help to achieve an acceptable level of profitability and risk, which affects the efficiency of investment activity. The practical significance of the Markowitz theory in assessing the investment portfolio of a mutual fund is substantiated.

4. Results and discussion

4.1. A mutual fund as a key element of the collective investment system

Collective investment is a complex structured system formation, having the following properties:

A large number of elements;

- The diversity of interconnections of the constituent parts;
- Each of the elements of the system has its own properties only in its composition;
- Indivisibility of the system, despite the large number of its elements;
- Isolation of the system itself from its infrastructure.

The key features of MF are the following:

- A mutual fund is not a legal entity, but a property complex;
- The property is transferred to the fund with the rights of partial use of possession and disposal for profit;
- Interest and dividends on shares are not accrued;
- There is no taxation of the fund's property and the growth of its property, as the mutual fund is not a subject to taxation;
- Depositors get profit or loss on the sale of shares in the form of difference between the costs when buying and selling their units.

The classification of mutual funds by opportunities of sale and redemption of shares is presented in Table 2.

Table 2. Types of mutual funds depending on temporary restrictions on sale/purchase of units by depositors.

Type of MF	Characteristics
Open-end	– There are no restrictions at the time of sale or purchase of the unit by the depositor; – The share price is calculated daily.
Interval	– The possibility of buying and selling unit is limited by a temporary window, which is determined by the charter documents of the fund; – The share cost is calculated monthly and at the end of each interval.
Closed-end	– Shares are redeemed from the investors on attainment of the purpose of the fund's existence or in other circumstances where the fund is closed; – This type of fund is usually created for a specific project; – The circulation of shares of such funds may be carried out in the secondary market (exchange or over-the-counter).
Exchange-traded	– Shares of such funds are directly related to exchanges and stock indices; – The circulation of shares is carried out on the exchanges; – The listing procedure is mandatory.

4.2. The investment portfolio of a mutual fund and criteria for its efficiency

Attracting investment in the mutual fund depends on many factors, divided into three blocks:

1) Investment attractiveness of MF;
2) Investment attractiveness of the management company;
3) Investment attractiveness of specific tools.

This grouping will allow selecting parameters and criteria for making decisions about investing in the fund and ranking the funds by attracting investment. Due to the investors' different goals, to each of the estimates for the blocks, weight should be assigned, which depends on the type of investor and investment objectives (Tables 3. – 5.).

Table 3. Factors of investment attractiveness of the mutual fund

Factor	Measurement unit	Possibility to compare
Yield	%	+/-
Volatility	%	+/-
Liquidity	Unit, point	+
Commission	%	+
Discounts and allowances	%	+
Composition and structure of assets	Types of assets, %	+/-
Taxation	%, term and tax base	+/-

Table 4. Factors of investment attractiveness of the management company (MC)

Factor	Measurement unit	Possibility to compare
Reputation of the MC of the mutual fund	Rating and image	+
History	Years, %	+/-
Range of funds	Types and number	+/-
Structure and structure of assets of the MC	Types of assets, %	+
Personnel qualification	Number of staff with diplomas and certificates	+
Degree of transparency of the activities	Publications on the web	

Table 5. Factors of investment attractiveness of financial instruments of the mutual fund

Factor	Measurement unit	Possibility to compare
Type of mutual funds	Open-end/closed-end/interval	+/-
The minimum contribution amount	Monetary unit	+
The workflow process	Quantity, simplicity of completion of documents	+
Exchange of shares	Time, %	+
Location, agency network	Convenience, number of agents	+

Such grouping of indicators will help to give an objective assessment for the feasibility of investing in the fund.

4.3. Assessment for the efficiency of investment portfolios of the largest Russian mutual funds

The changes taking place in the dynamics of the mutual fund market structure should not go unmentioned. If at the beginning of their activities, all funds were of an interval type, which was determined by the desire to retain the funds of the shareholders in the funds, by the crisis of 2008 there was a tendency to increasing the unit of closed-end funds. As for the development of certain types of funds, we can see the following. Over the period of 2010-2017, the share of funds investing in funds increased compared to the proportion of stock funds and money market funds. There is also a tendency of increasing the share of bond funds (Figure 2.).

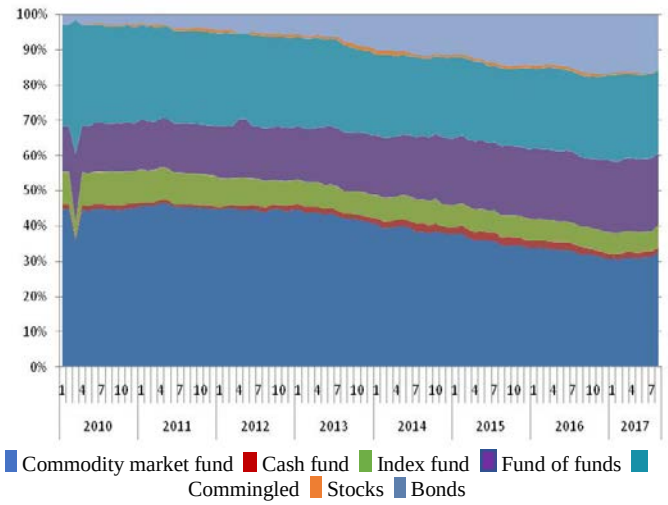

Figure 2. Dynamics of units of open-end and interval funds by type. Compiled based on Investfunds [19].

The dynamics of the value of net assets of mutual funds confirms the investment attractiveness of bond funds due to the devaluation of the ruble against the background of anti-Russian sanctions (Figure 3.).

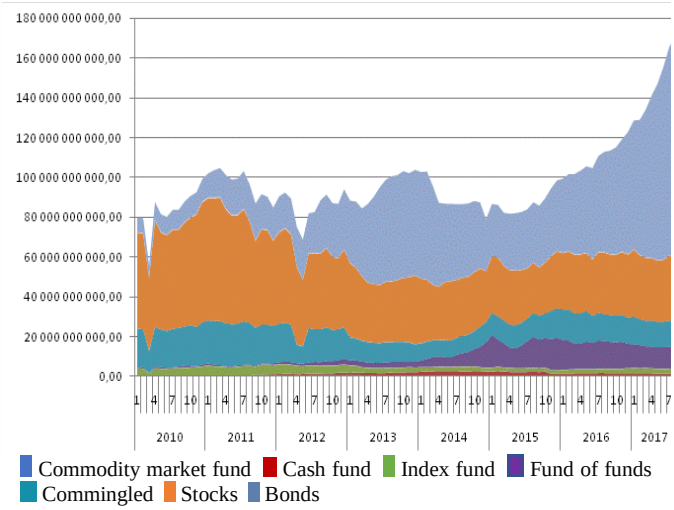

Figure 3. The dynamics of the value of net assets of open-end and interval funds for 2010-2017. Compiled by the authors using data of Investfunds [19].

In assessing the effectiveness of the funds' strategies, the following results were obtained:

- There are the largest volumes of assets in the segment of bond funds in August 2017 (64.58%);
- Stock funds yielding an average of 3.6% of yield monthly can be recognized the most profitable for 2017, index funds with 3.41% of yield are in the second place, and commingled funds achieve 2.03% of yield per month on average. Bond funds are in the fourth place in terms of profitability and bring an average of 1.43% from month to month;
- Stock funds can be characterized by effective management of their assets, bonds, commingled and index funds, as the average value of their yield exceeds benchmarks bringing Jensen's alpha in a positive area of values;
- The management of foreign exchange funds can be recognized nominally effective (there is an increase in the share value, but it does not block the benchmark), although in 2017 the situation becomes better showing the excess of the Jensen's alpha over the official rate of inflation;
- Two strategies of funds, namely investments in commodity markets and other funds, are currently irrelevant, as there is no even a nominal increase in the value of the share;
- The least risky investment strategy is investing in the stock fund with a standard deviation of about 3%;
- The least attractive from the point of view of riskiness are the index funds with 16% standard deviation.

4.4. Economic and mathematical modeling and its role in evaluating the optimal investment portfolio of a mutual fund

There are various financial ratios developing the idea of the need to measure the risk-return ratio but each of them is not completely objective:

- The Sharpe ratio is criticized for the fact that it takes into account all volatility [20];
- Jensen's alpha tends to change over time, with its consistency, which could be caused by strong changes in market conditions, in which the manager's capabilities would be useless or simply by luck of the manager in previous periods.
- Other coefficients that use the standard deviation metric in one form or another.

The disadvantage of using the standard deviation as a measure of risk from a statistical point of view is the reference to the form of distribution of returns, namely to the normal distribution, but this premise cannot be fulfilled [14]. To demonstrate the above, the histograms of the Moscow Interbank Currency Exchange (MICEX) index returns on weekly and daily closing price data were analyzed. Very often, the analysis of descriptive statistics of a set of returns raises the question of the so-called distribution "thick tails", which in practice are expressed in greater probability of extreme values than the Gaussian assumes (Figure 4.).

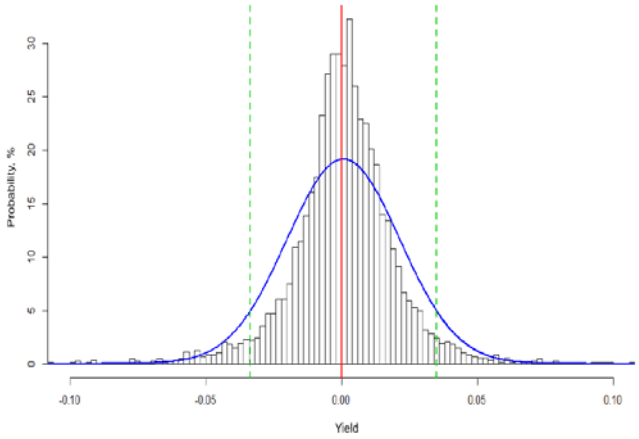

Figure 4. Daily return of the MICEX index for 2000-2017. Compiled based on Finam Company's data [21].

When describing the distribution of financial data, the asymmetry index is extremely important, as it is able to show in which side the distribution is shifted. In the case of right-sided asymmetry, there is a tendency for empirical data to overestimate yields in comparison with theoretical one, which, of course, will only benefit the investor and the manager [14].

In the rather frequent case of left-sided asymmetry, the reverse should be expected when actual results differ for the worse in comparison to theoretical calculations. The violation of the assumption about the normal distribution of returns leads to distortion of the results of the variance study often underestimating the possible losses [22]. The solution to this problem is to assign weights to the maximum losses, which will partially correct the situation [21]. As can be seen from Figure 4., the distribution of daily returns has "heavy tails"; besides, it differs from the normal one. However, if to consider large time intervals the situation is corrected. Below are diagrams based on monthly data on the yield of the MICEX index (Figure 5.).

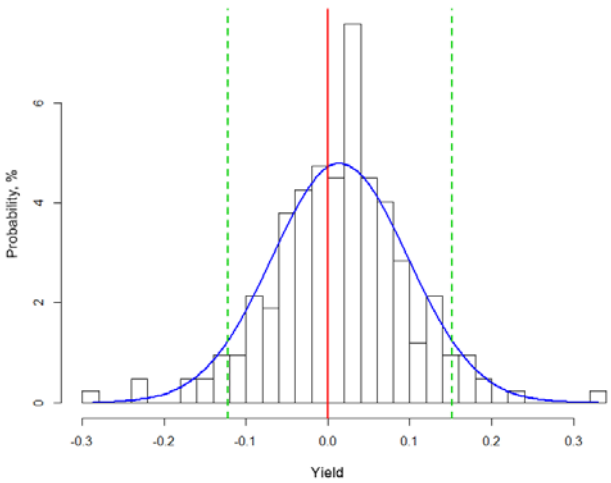

Figure 5. Monthly returns on the MICEX index for 2000-2017. Compiled based on data of Finam Company [21].

From these diagrams, it is concluded that the increase in the investment horizon when calculating the statistical characteristics of the portfolio can make the calculation more adequate, as it does not absorb the small fluctuations associated with speculative or accidental movements of the market, but the problem of "heavy tails" is still unresolved.

For further analysis through the VaR method, stocks of issuers included in the MICEX index were chosen. The choice of these stocks is justified by the fact that in addition to price security, it is necessary to take into account the security of the value document liquidity, i.e. the reduction in demand for it, which would lead to the inability to sell the financial asset without additional expenditure of funds and time. Choosing value documents included in the MICEX index, we thus protect ourselves.

Modern methods of risk identification, despite the fact that none of them is completely objective, can be used to create a single integrated system of stock selection assessment. The basis of the proposed mechanism for the selection of investment tools is the methods of clustering k-mean process (iterative selection of centers, which has the property of sufficiently stable convergence and requires only specifying the number of groups at the input), which will allow dividing into clusters – similar in characteristics of the population.

It was decided to carry out two clusterings into 3 groups each and to divide 30 stocks included in the MICEX index at the time of August 2017 on the following grounds:

- Yield;
- Risk of investment;
- The rates of yield are;
- The average daily yield on stocks for 2010-2017;
- The median of yield on stocks for 2010-2017;
- The volume of the observed population will give a stable estimate of the average, which will be little subject to change in time in the future, and will allow counting on mitigating the premise of the need to comply with the normal distribution law in the data.

Risk measures will be metrics calculated based on daily data:

- Standard deviation;
- VaR;
- ES – expected shortfall, a complementary VaR indicator calculated as the average of the returns behind the "boundary" quantile of the distribution of returns on which the VaR "stops".

According to the results of clustering, the following data was obtained (Figure 6.).

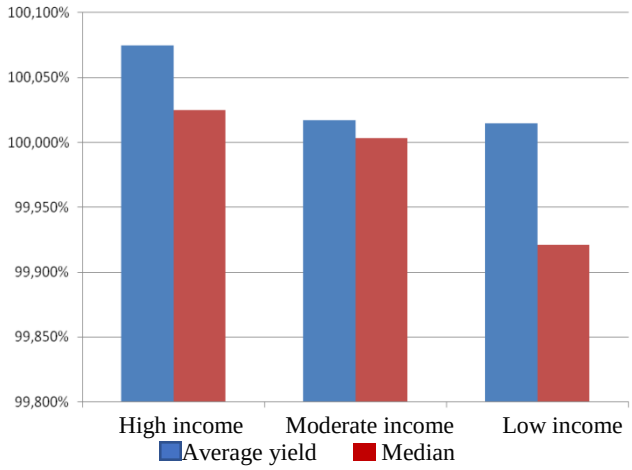

Figure 6. Characteristics of clusters profitability by income. Compiled based on data of Finam Company [21].

Concerning other clusters in the group of stocks with moderate income, the value of the median is fairly close to the average, which indicates the homogeneity of the group and the smallest of all differences in the values between the averages of individual assets in the group (Tables 6. – 7.).

Table 6. Summary characteristics of the clusters by risk

Cluster by risk	Standard deviation	Value at Risk	Expected Shortfall
Low risk	1.92%	-2.85%	-4.21%
Moderate risk	2.40%	-3.36%	-5.05%
High risk	3.95%	-4.44%	-7.59%

As a result of clustering, the stocks were divided into groups (Table 7.).

Table 7. Distribution of stocks by class.

Cluster by yield	Cluster by risk	Stock
High income	Low risk	AEROFLOT, GMKNorNik, LUKOIL, MAGNET JSC, MOSBIRZHA, NOVATEK JSC, ZAO PIK, POLYUSZOLOT, SURGNFGZ-P, ZAO TATNFT
	Moderate risk	ALROSA JSC, MMK, SBERBANK, SBERBANK-P, TRANSNF AP
Low income	Low risk	GAZPROM JSC, ROSTEL JSC, NLMK JSC
	Moderate risk	RUSAL RDR, RUSHYDRO
	High risk	FGC UES JSC, MECHEL JSC, ChMK JSC, VTB JSC
Moderate income	Low risk	MEGAFON JSC, MTS JSC, ROSNEFT, SURGNFGZ
	Moderate risk	PHOSAGRO JSC
	High risk	SISTEMA JSC

High-income and moderate- and low-risk stocks were selected for further analysis and making portfolios (Table 8.).

Table 8. Characteristics of groups

		High risk	Moderate risk	Low risk
Average annual yield	High income	-	121.94%	120.46 %
Value at Risk		-	-3.30%	-2.92%
Average annual yield	Moderate income	107.04 %	100.46%	104.73 %
Value at Risk		-3.56%	-2.85%	-2.75%
Average annual yield	Low income	111.21 %	104.15%	96.46%
Value at Risk		-4.88%	-3.55%	-2.71%

Optimizing the weight of the obtained portfolio, the following results were achieved:

- The expected annual yield at 29.6%;
- Average monthly standard deviation was 23.4%.

If we compare the results with those obtained in the optimization of the entire portfolio of 30 stocks, the portfolio of clustered securities shows a lower yield, but also a lower standard deviation, despite the fact that the diversification from the portfolio of twice as many securities was almost at the level of clustered data (the standard monthly deviation was 23% in the data processed and 24% in the non-processed one).

5. Discussion

The obtained result shows that the use of mathematical methods in relation to the theory of portfolio investment can seriously affect the result of the portfolio manager's activities.

Markowits's model should be used at the first stage of investment portfolio formation when allocating capital by various types of assets (stocks, bonds, real estate, etc.). At the second stage, when investments in a certain segment of the asset market are distributed among their individual components (that is, between specific stocks, bonds and other securities), Sharpe's single-factor model should be applied.

It should be noted that in the instability (volatility) of equity markets the use of mathematical methods and models does not always mean a guaranteed result. However, despite this limitation, optimization models of the investment portfolio structure help to achieve an acceptable level of profitability and risk, which affects the efficiency of investment activity.

The advantage of the developed technique is the possibility of its use in modeling the securities portfolios of mutual funds focused on non-

professional investors. Practical implementation of the methodology will help to attract new investors to the Russian equity market, which will ensure the growth of its liquidity, as well as the inflow of long-term investments in the development of the real sector of the economy.

In the future, it is necessary to find other metrics of efficiency and risk, which may give a more efficient clustering and further simplify the use of the presented technique.

6. Conclusion

Thus, as a result of the conducted study, it can be noted that at present the development of mutual funds in Russia is of special importance. The market for collective investment will contribute to the transformation of the population's savings into investments by investing money not only in such traditional instruments as bank deposits, but also in more risky assets by type of securities, derivatives and structured financial products. In selecting a mutual fund, the investor should pay closer attention to the issues of profitability and risk, which cannot be done without the tools of economic and mathematical modeling. These tools will allow designing the most optimal investment portfolio within the investment strategy that the investor wants to implement.

References.

[1] Bauerle, N., & Grether, S. (2015). Complete markets do not allow free cash flow streams. *Mathematical methods of operations research*, *81*(2), 137-146. DOI: 10.1007/s00186-014-0489-2.

[2] Grinblatt, M., & Titman, S. (1987). The relation between mean-variance efficiency and arbitrage pricing. *Journal of business*, *60*(1), 97-112. DOI: 10.1086/296387

[3] National League of Management Companies. (2018). *Market statistics*. Retrieved from: http://www.nlu.ru/stat-count_pifs.htm [accessed: 15 November 2018].

[4] Aït-Sahalia, Y., & Jacod, J. (2012). Analyzing the spectrum of asset returns: Jump and volatility components in high frequency data. *Journal of Economic Literature*, *50*(4), 1007-50. DOI: 10.3386/w15808.

[5] Sharpe, W. (1994). The Sharpe ratio. *Journal of portfolio management*, *21*(1), 49-58. DOI: 10.3905/jpm.1994.409501.

[6] Sortino, F. A., & Price, L. N. (1994). Performance measurement in a downside risk framework. *The Journal of Investing*, *3(3), 59-64.* DOI: *10.3905/joi.3.3.59.*

[7] Treynor, J. (2007). *Institutional investment*. New Jersey: John Willey &Sons, Inc., Hoboken.

[8] Wang, J. & Forsyth, P. (2012). Comparison of mean variance like strategies for optimal asset allocation problems. *International journal of theoretical and applied finance*, *15*(2), 1-33. DOI: 10.1142/S0219024912500148.

[9] Deng, Z., Bai, Y., Fang, S. C., Tian, Y., & Xing, W. (2013). A branch-and-cut approach to portfolio selection with marginal risk control in a linear conic programming framework. *Journal of systems science and systems engineering*, *22*(4), 385-400. DOI: 10.1007/s11518-013-5234-5.

[10] Bai, Y., Wei, Y., & Li, Q. (2017). An optimal trade-off model for portfolio selection with sensitivity of parameters. *Journal of industrial & management optimization*, *13*(2), 947-965. DOI: 10.3934/jimo.2016055.

[11] Bailey, D. H., & Lopez de Prado, M. (2012). The Sharpe ratio efficient frontier. *Journal of Risk*, *15*(2), 13. DOI: 10.2139/ssrn.1821643.

[12] Almgren, R. (2012). Optimal trading with stochastic liquidity and volatility. *SIAM Journal on Financial Mathematics*, *3*(1), 163-181. DOI: 10.1137/090763470.

[13] Vigna, E. (2014). On efficiency of mean–variance based portfolio selection in defined contribution pension schemes. *Quantitative finance*, *14*(2), 237-258. DOI: 10.1080/14697688. 2012.708778.

[14] Dang, D., Forsyth, P., & Vetzal, K. (2017). The 4% strategy revisited: A pre-commitment optimal mean-variance approach to wealth management. *Quantitative Finance*, *17*, 335-351. DOI: 10.1080/14697688.2016.1205211.

[15] Huang, Y., Forsyth, P. A., & Labahn, G. (2012). Combined Fixed Point and Policy Iteration for Hamilton--Jacobi--Bellman Equations in Finance. *SIAM Journal on Numerical Analysis*, *50*(4), 1861-1882. DOI: 10.1137/100812641.

[16] Chen, Z. P., Liu, J., & Li, G. (2016). Time consistent policy of multi-period mean-variance problem in stochastic markets. *J. Ind. Manag. Optim*, *12*(1), 229-249. DOI: 10.3934/jimo.2016.12.229.

[17] Markowitz, H. (1952). Portfolio selection. *The journal of finance*, *7*(1), 77-91. DOI: 10.2307/2975974.

[18] Witt, S., & Dobbins, R. (1979). The Markowitz contribution to portfolio theory. *Managerial finance*, *5*(1), 3-17. DOI: 10.1108/eb013433.

[19] Investfunds. (2018). *Search for funds.* Retrieved from: http://pif.investfunds.ru/funds/ [accessed: 07 February 2019].

[20] Cvitanić, J., Lazrak, A., & Wang, T. (2008). Implications of the Sharpe ratio as a performance measure in multi-period settings. *Journal of Economic Dynamics and Control*, *32*(5), 1622-1649. DOI: 10.1016/j.jedc.2007.06.009.

[21] Finam Company. (2018). *Statistics.* Retrieved from: https://www.finam.ru/analysis/macroevent/ [accessed: 10 October 2018].

[22] Cui, X., Gao, J., Li, X., & Li, D. (2014). Optimal multi-period mean–variance policy under no-shorting constraint. *European Journal of Operational Research*, *234*(2), 459-468. DOI: 10.1016/j.ejor.2013.02.040.