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Modification of the Three-Factor Fama-French Model and its Application to Assess the Efficiency of the Portfolio Management of Russian Investment Funds

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ABSTRACT

The subject of the paper is the activity of managers of Russian investment funds. **The aim** of the paper is to determine the possibility of using widely applied abroad methods of assessment of the managers' diving abilities in the Russian practice, adaptation to the conditions of the Russian market of the three — factor Fama-French model. The **methods** of analysis and synthesis, quantitative assessment, including in relation to the study of the assessment of the portfolio managers picking abilities, are used as the main research methods. **The relevance** of the research is to make proposals on the transformation of the Russian approach to assess the performance of collective investment fund managers and its subsequent practical use. The article presents the results of a statistical assessment of the effectiveness of the activities of Russian managers of open-end investment funds shares from the perspective of micro-forecasting. According to the **results** of the research, conclusions are drawn that both the multifactorial Fama-French regression and CAPM, traditionally used in foreign practice, tested on the data of the Russian stock market, have sufficient predictive abilities and allow to obtain statistically significant estimations of variables and finally can be **recommended** for practical use in Russia. **The novelty** of the research consists in the development of the author's modification of the three-factor Fama-French regression (a model with the SPX-factor), which allows to obtain better regression factors estimations in comparison with the basic model, more accurately explains the process of excess returns generation of Russian open-end investment funds and can be recommended for practical use. **The result** of the statistical analysis is the conclusion that the processes of portfolio management of Russian investment funds in 2009–2019 were characterized by a lack of managers' skill for successful picking, the profitability received by the funds was more ensured by random factors.
Keywords: investment funds; micro-forecasting; picking; multifactor regression; Fama-French alpha; Jensen alpha

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INTRODUCTION

The effectiveness of the Russian institutions of collective investment today is assessed extremely low, despite the implementation of a wide range of measures, over which the research started more than twenty years ago, and the potential of Russian institutional investors remains unfulfilled. The current state of the regulatory system, problems of information transparency as well as and market factors have led to the stagnation of the Russian mutual funds' sector and have largely led to a shortage of long-term sources of financing, is a key constraint on the development of the Russian economy.

In the absence of a statutory responsibility of the manager for the reduction of the market value of the property transferred to management, the risks of changes in the value of assets of mutual investment funds (hereinafter — MIF) are transferred to fund shareholders. These risks are not only realized for external reasons, but are also directly caused by management actions, including behavioral factors, the so-called "management abilities".

It is entirely possible that, when choosing an investment fund as an investment object, the measure of the effectiveness of the MIF portfolio management should be considered

in the quantitative evaluation of the factors, affecting the outcome of the investment. This approach will separate fortuitous circumstances management result from effective management achieved through the application of managerial skills and competencies.

In contrast to foreign practice, Russian experience in assessing the effectiveness of the collective investment segment is extremely limited. Moreover, the available domestic developments in the field of multifactor modelling [1] that could be used to assess the activities of MIF managers, have no practical application in Russia. Consequently, in most cases the assessment of the results of portfolio management in Russia is based on a coefficient analysis (in particular, the Sharpe ratio, Sortino ratio etc.) as well as on the subsequent ranking of the funds by the values of the calculated coefficients and other indicators (for example, on the value of net assets, annual returns, etc.).

The practical application of the above ratios concerning the assessing the results of portfolio management of investment funds is limited in terms of econometric modeling that both foreign authors and some Russian researchers have repeatedly pointed out [2–6]. This conclusion is due to the fact that the methodology of calculating these coefficients assumes the execution preconditions on the stationarity and parameterity of MIFs income generation process, which in practice is difficult to implement, and therefore rarely occurs [7, 8]. Moreover, the application of different ways to get rid time series from non-stationary (using, for example, DSGE models) gives rise to a distortion logic of the calculation of Sharpe ratio, Sortino etc. as a result, such time-series adjustments cannot be used in order to calculate these metrics in terms of investment fund efficiency [9].

From the point of view of the comprehensive analysis of the performance of MIF portfolio management, the use of coefficient analysis metrics as a unified determinant of the performance of fund portfolio management cannot be recommended because of the high probability of incorrect interpretation payments. This may lead, among other factors, to the investor's misperception of market conditions and may lead to the distortion of their investment priorities.

ADAPTION OF MULTI-FACTOR METRICS TO ASSESS THE EFFECTIVENESS MANAGEMENT OF MUTUAL INVESTMENT FUNDS

Considering the abovementioned, the purpose of this paper is (1) to determine the feasibility of using foreign multifactor metrics, widely used abroad to assess the effectiveness of MIF's portfolio management, and applying management specific management skills as determinants of efficiency (in particular to successful market picking); (2) to test these methods on data of the Russian market, and (3) to adapt the 3-factor regression of Fama-French to the conditions of the Russian market for the possibility of its subsequent practical use in the Russian practice.

The logic of constructing factor modeling metrics, traditionally used in foreign practice, is largely based on the results of E. Fama and M. Jensen studies [10], conducted with the purpose of seeking a new approach to assessing the effectiveness of fund management and leveling the problem of obtaining "imaginary" estimates of regression factors that inevitably arise when using single factor estimation methods for this purpose. As a result, the authors of the attribution approach proposed to decompose the factors affecting the assessed performance of portfolio management of collective funds. At the same time, the significance of the influence of individual factors E. Fama and M. Jensen made it necessary for managers to have the ability to predict, i.e. picking skills and (selection of undervalued assets, the future return on which will exceed the expected market return) the ability to

successful timing the market (successful management of systemic portfolio risk) [10].

It was later empirically proved that these indicators could be assessed independently [11]. Furthermore, E. Fama and M. Jensen's assumption that it is impossible to use only one-factor metrics to assess the results of portfolio management funds, as they cannot be characterized by a constant level of risk, which is determined by the investment nature of collective investment funds, was also proved [12].

The most common factor metric used in foreign practice to assess managers' ability to pick a market is based on the CAPM Jensen alpha excess return concept (α) [13] (1):

$$\alpha = r - \left(r_f + \beta_p \bullet \left(r_m - r_f\right)\right), \quad (1)$$

where r — portfolio return; r_f — risk-free profitability; r_m — return on the market portfolio; β_p — portfolio market risk.

The picking indicator, called in this concept "alpha", allows to determine a part of the investment portfolio actual yield, obtained as a result of manager's actions, which allowed to surpass the market, i.e. its skill in managing the fund's portfolio is to accept a non-diversified risk component and at the same time to earn above-market return. Thus, the positive Jensen alpha indicates the ability to micro forecasting, while the negative — the lack of it.

The proposed approach was further modified, subsequently the addition of previously unaccounted factors to the basic model contributed a lot of the explanatory abilities of Jensen's alpha. At the same time, the main changes in the logic of the proposed metrics affected mostly the choice of the benchmark profitability model.

In particular, Fama and French proposed a three-factor alpha model in 1993, adding SMB and HML factors to Jensen's metric, as a result of which the explanatory strength of regression increased significantly [14]. The authors of the three-factor model, based on the analysis of North American stock market data for the period from 1962 to 1990, empirically proved that, all other things being equal, return of a security is influenced by the size of the issuing company along with compensation for market risk, ratio of price and balance sheet value of assets. Thus, in order to assess picking-ability of portfolio managers of investment funds, they supplemented the parametric model by these two factors (2):

$$\alpha_{FF} = \left(r_p - r_f\right) - \beta_1\left(r_m - r_f\right) - \beta_2 SMB - \beta_3 HML, \quad (2)$$

where: *SMB* — size factor defined as the difference between companies of small and large capitalization; *HML* is calculated as the difference between yield of companies' share with a high and low balance-to-market ratio.

The conclusion about the presence (absence) of management ability to successful picking the market is based on the interpretation of three-factor alpha (α_{FF}): positive alpha indicates the presence of the ability to pick the market, negative — lack of it, as a result, the explanation of the profitability obtained by the factor of "success".

The three-factor alpha model, further tested in foreign markets [15–17], in most cases was statistically significant, owned sustainable explanatory and sufficiently explained the MIF return variation (on average at 35%, in some cases up to 70% of variation in profitability [17]).

In 1997 M. Carhart improved the predictive abilities of this model by supplementing its specification with a momentum factor [18] [M. Carhart's four-factor model (3)]:

$$\alpha_C = \left(r_p - r_f\right) - \beta_1\left(r_m - r_f\right) - \beta_2 SMB - \beta_3 HML - \beta_4 WML, \quad (3)$$

where: *WML* — momentum effect, is the amount of variation of economic returns between the papers with the best and worst rates of return over the period.

The effectiveness of investment strategies with momentum effect has been repeatedly

confirmed in later researches. At the same time, such factors, as the capital market degree of development, on which the realization of the momentum-strategy remains contentious issue is expected. In particular, empirical studies have demonstrated that the presence of momentum is questionable in emerging markets [19, 20], as well as the quality of the Carhart regression is often insufficient for both the parametric model and its individual regressions [21].

However, the implementation of the momentum-strategy objectively implies a substantial, systematic rebalancing of the portfolio, so that this type of investment strategy can be sensitive to the factor of liquidity [22].

Thus, the inclusion of a factor in the base regression that would determine the share of portfolio return due to the impulse effect could theoretically have a positive impact on the quality of regression modelling. Especially since the tested by M. Carhart method on sample data showed lower regression errors than not only CAPM, but also the three-factor model Fama and French [18].

In 2014, based on this metric, E. Fama and K. French proposed a five-factor alpha [23] model, supplemented the regression specification with *RMW* (low profit premium), and *CMA* factors (low investment premium) (4):

$$\alpha_{FF5} = \left(r_p - r_f\right) - \beta_1\left(r_m - r_f\right) - \beta_2 SMB - \\ - \beta_3 HML\beta - \beta_4 RMW - \beta_5 CMA. \quad (4)$$

This model has better explanatory capabilities than their previous three-factor alpha model and provides the researcher with better estimations of the overall alpha and individual factors influencing the excess portfolio return. However, at the same time, the method of calculation of 5-factor alpha involves the implementation of estimation by a more complex algorithm, which seems to be critical when developing the tools, accessible and easily replicable by private investors in the process of selecting investment funds for investment.

MATERIAL AND METHODS

The possibility of practical use in the Russian practice the above mentioned multi-factual metrics in order to assess the picking-abilities of MIF managers is determined in this paper by testing on the data of the Russian market three-factor Fama-French model and Jensen alpha. The quality of the Fama-French regression is correlated with the CAPM indicators.

Empirical analysis of MIF portfolio management efficiency is based on evaluation of panel multi-factor regression based on the econometric package Eviews 8. This appears to be the more illustrative and more representative than the bootstrap modeling procedure, widely tested in foreign research of the investment funds market [18, 24, 25], as well as described in the works of some Russian authors [3, 26].

As the determinant of the fund's portfolio management efficiency, we consider the presence (absence) of managers selected for the research 47 open-end investment funds shares (OEF) of micro-forecasting skills for a 10-year period of research (2009–2019).

To obtain more representative results, the evaluation period was split into five sub-periods (*Table 1*), whose length corresponds to key trends in the evolution of the benchmark chosen for the research — *RTSI* index (*Fig. 1*). The additional sixth sample is taken to be equal to the length of the entire research period (08.06.2009–31.05.2019). In the future, such a breakdown of the evaluation period will allow to determine the strength of the explanatory abilities of the tested metrics at different stages of the business cycle, which are traced in the dynamics of *RTSI* at a selected time period.

For the further calculations, we use weekly values of OEF sample profitability, *RTSI* index, risk-free rate of return. The choice of frequency of calculation data is due to the fact, that weekly data are least affected by the

Table 1

Sub-Periods for Models Testing

No.	Period	Description of the period
1	08.06.2009–08.04.2011	Unrestrained growth
2	09.04.2011–09.07.2014	Gradual decline
3	10.07.2014–16.12.2014	Sharp decline
4	17.12.2014–20.01.2016	Recovery
5	21.01.2016–31.05.2019	Stabilization
6	08.06.2009–31.05.2019	Entire evaluation period

Source: Compiled on the data from MOEX (accessed on 12.11.2019).

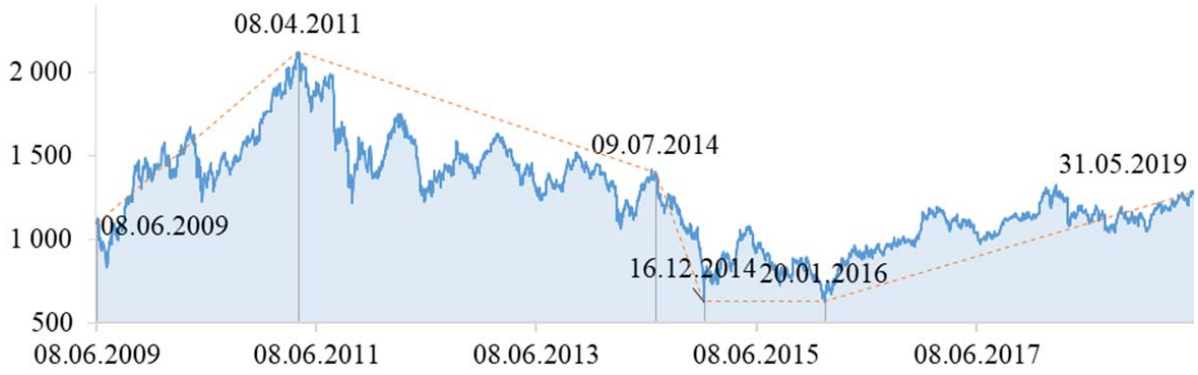

Fig. 1. ***RTSI*** **Dynamics, 06.08.2009–05.31.2019**

Source: Compiled on the data from MOEX (accessed on 12.11.2019).

volatility of the market in comparison with the daily profitability and at the same time less manipulative than the monthly or annual profitability.

Note that calculation of factors *SMB* and *HML* is determined as the differences in market indices (*MSCI* Russia), not by the original methodology:

1) *HML* counted by subtracting the weekly profitability of the *MSCI* growth index from the corresponding profitability of the *MSCI* Value index;

2) *SMB* calculated as the difference between the weekly profitability of *MSCI* Large Cap and *MSCI* Small Cap.

We consider the estimation based on this algorithm of finding the second and third factors of Fama-French model can be possible due to the high concentration of the Russian financial market, as well as the specifics of the calculation of national stock indices.

Besides, we take into the consideration, that the key factor in the *MIF* sample construction was the direction of investment (i.e. the stock), but not the type of management strategy, and the presence of a strong correlation between the *MIF* returns of the sample and the benchmark (*Fig. 2*). To eliminate the negative effect of the false correlation of the returns of individual funds with the return of *RTSI*, we rank the funds on the increase of the index of gross return of portfolios for the evaluation period.

Thus, portfolio managers' picking-abilities in this study we determine both for the whole sample and for the funds grouped into four quartiles (Q1–Q4) by the average annual actual return of MIF portfolios for the entire observation period.

The statistical characteristics of the received quartiles, including the nature of return distribution (adjusted for average and median values), as well as the correlation with the benchmark, generally correspond to the characteristics of the MIF sample (*Table 2*).

RESULTS

The testing and approbation of three-factor Fama-French regression allowed us to make the following conclusions.

The model has sufficient predictive abilities, the quality of regression (*Adj* R^2) in some periods significantly exceeds the quality of CAPM (in the 4th and 5th crisis and post-crisis samples, the Fama-French regression quality was estimated at average at 22.0% against 7.2 and 23.3% calculated at CAPM), which suggests that the three-factor model demonstrates the better results. Moreover, the estimated parameters of the regression are statistically sustainable (*Fig. 3*).

The quality of both regressions tends to improve on the upstream phases of the business cycle, confirming the finding that portfolio managers' skills are subject to change in different phases of the business cycle [27].

The β-coefficient in both models is stable for the entire sample size and for the funds of each quartile Q1-Q4. The greater statistical significance of β is observed in the estimations of the three-factor model (the value of the index "*Std. Error* β" on average for the research period at 0.0017; the index "*Probability* β" — at the level of 0%). At the same time the observed values of this factor, estimated using CAPM have minimal influence on the actual profitability of the sample funds (beta value in CAPM is minimal on the 3rd and 4th sample, takes values from 0.11 to 0.32).

Fig. 2. **Correlation Profitability of Open-End Investment Funds and *RTSI*, 06.08.2009–05.31.2019**

Source: Compiled by the authors based on the calculation in Eviews 8.

The influence of *HML* and *SMB* factors of the Fama-French model on the profitability of MIF and the quality of regression in general in the sample seems to be ambiguous. For the whole sample these factors have different degrees of influence (HML takes values in the range from –0.004 to 0.005; *SMB* — from –0.034 to 0.033), as well as different type of influence on the final profitability of mutual funds (on the relevant sample estimation of these factors are predominantly opposite signs). The estimated values of *HML* and *SMB* factors are distributed near zero point, with no apparent correlation with stages of the economic cycle (*Fig. 4*).

We consider that the practical application of the three-factor Fama-French model in order to evaluate Russian managers picking abilities is justified. During the study, we managed to collect all the needed data in order to construct the regression variables, our estimations are statistically significant and the model has sufficient predictive abilities at a higher level than the quality of the CAPM.

Table 2

Distribution of Open-End Investment Funds Profitability by Quartile Q1–Q4

Indicator	All Funds	Q1	Q2	Q3	Q4
Median	0.2136%	0.1197%	0.1977%	0.2357%	0.3017%
Maximum	25.4406%	17.5454%	24.0333%	25.4406%	17.4819%
Minimum	–23.0194%	–21.3457%	–23.0194%	–19.1262%	–20.8283%
Std. Dev.	0.028035	0.029485	0.027755	0.026514	0.028148
Skewness	–0.253332	–0.410004	–0.177167	–0.156385	–0.206904
Kurtosis	6.864838	6.740433	6.953679	7.188413	6.527841
Jarque-Bera	77509.93	19098.88	20523.67	21062.18	16433.51
Probability	0	0	0	0	0
Observations	122435	31260	31260	28655	31260

Source: Compiled based on the calculation in Eviews 8.

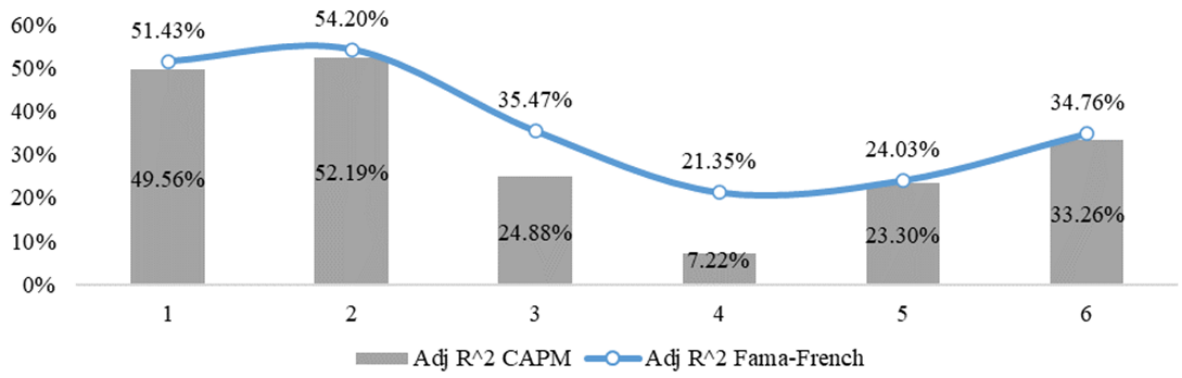

Fig. 3. **Quality of CAPM and Fama-French Model on the Samples 1–6**

Source: Compiled based on the calculation in Eviews 8.

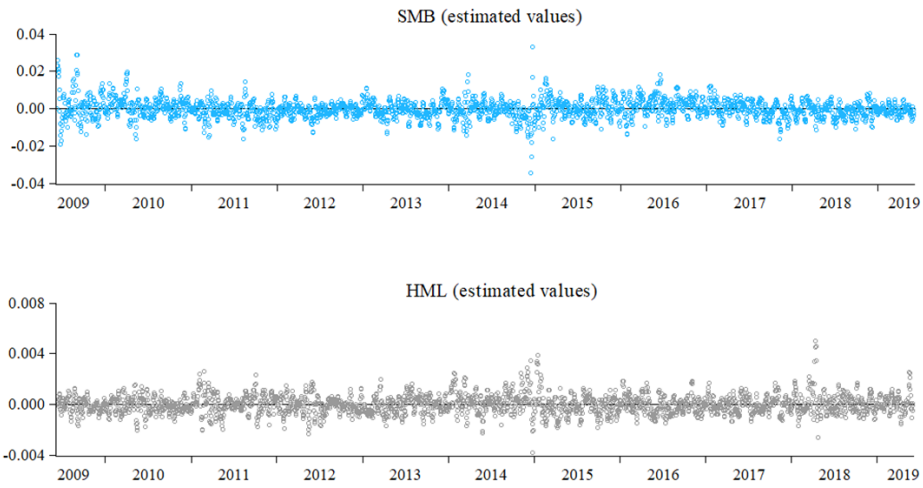

Fig. 4. **Distribution of *HML* and *SMB* Factor of Fama-French Model, 2009–2019**

Source: Compiled by the authors based on the calculation in Eviews 8.

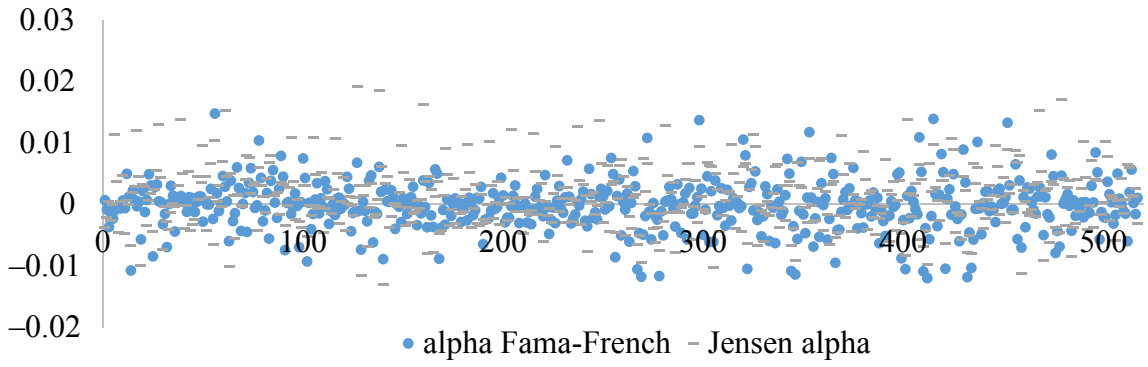

Fig. 5. **Distribution of Fama-French Alpha for Open-End Investment Funds of the Sample**

Source: Compiled based on the calculation in Eviews 8.

More than that, the proposed simplification of the *HML* and *SMB* factors calculation methodology did not have a significant effect on the results interpretation: evaluations are comparable to previous researches (D. M. Murav'ev [3], P. A. Parshakov [26]). Therefore, we consider the possibility of these factors' calculation according to our proposed methodology.

It is noteworthy that both the average annual Fama-French alpha and Jensen alpha are grouped around the zero point. However, there is not any constant trend and alpha distribution dependency (*Fig. 5*).

According to the results of our statistical assessment, the positive excess return, which could indicate the effectiveness of the management of MIF's portfolios, was determined in most cases by random factors. On average, less than half of MIFs (49.1%) crushed the market while only 10 funds have shown a positive excess return for at least 7 periods.

One of the main trends observed in the Russian collective investment market in recent years is a significant rebalancing of MIFs investment portfolios, in particular OEF stock portfolios, in which the share of foreign bonds in 2014–2019 has doubled (up to 38.0% portfolio by 2019).

Perhaps, taking into the consideration the factor of foreign investments will have some impact on the explanatory abilities of Fama-French 3-factor regression. We propose to test the following model and to compare its results with the estimations of the Fama-French alpha (5):

$$\alpha_{\text{mod}} = (r_p - r_f) - \beta_1 (r_m - r_f) - \beta_2 SMB - \beta_3 HML - \beta_4 SPX, \quad (5)$$

where β_1, β_2, β_3 — coefficients under the factors of the three-factor model Fama-French; β_4 — coefficient, reflecting the influence of the foreign investments (hereinafter — *SPX*-factor, as part of this research — weekly profitability of the S&P 500 Index) on the return of Russian MIF shares.

Testing an *SPX*-factor model provided us with some unexpected results. On the one hand, the modification of basic model with this factor did not have significant influence on its quality: *Adj* R^2 basic and *SPX*-factor models are comparable for the MIF of the entire sample and for the funds of quartiles Q1-Q4 on all samples (*Fig. 6*).

The marginal impact of the foreign investment factor on the MIF excess return distribution of the sample cannot be described as significant (for the whole sample between 0.00029 and 0.02271), even there are no sign of the stochastic process in its distribution, unlike other model factors. Besides, there is an obvious presence of the trend in the *SPX*-factor distribution (*Fig. 7*), which supports the assumption that the rebalancing of OEF portfolios during the valuation period was significant.

At the same time, the results of a residuals testing procedure demonstrate that *SPX*-factor

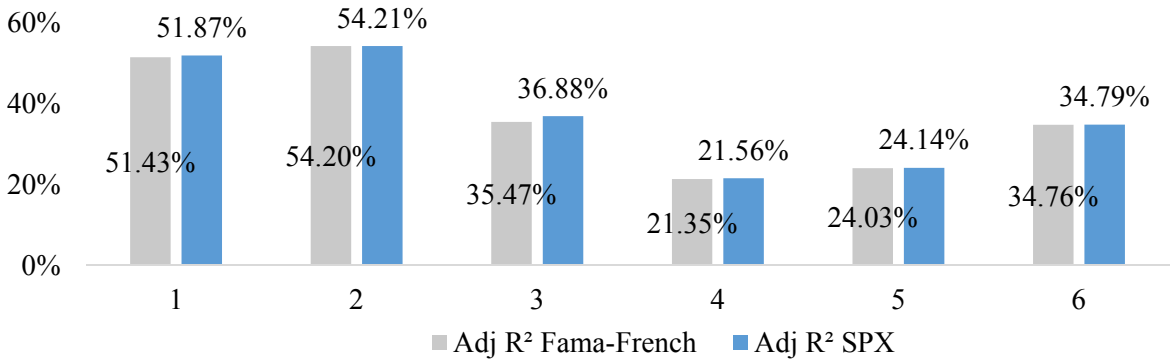

Fig. 6. ***Adj R²*** **for Fama-French Model with *SPX*-Factor, Estimation for Samples 1–6**

Source: Compiled based on the calculation in Eviews 8.

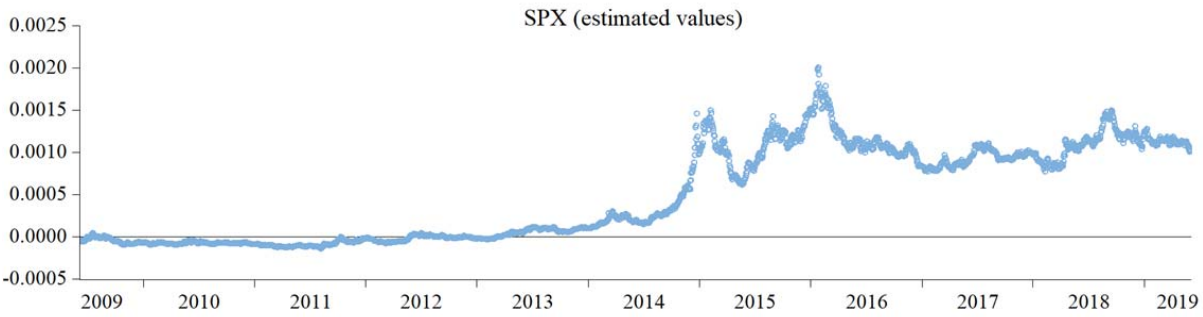

Fig. 7. **Distribution of the Estimated SPX-Factor, 06.08.2009–05.31.2019**

Source: Compiled based on the calculation in Eviews 8.

still allows obtaining more accurate results of factors' estimation than the basic 3-factor model.

In this case, the actual values of the modified alpha allow judging the more modest (even in comparison with the alpha Fama-French) ability of the Russian managers to pick the market: 48–90% of the sample stocks have confirmed this proficiency by year (additional data may be provided).

However, it seems to be obvious that the *SPX*-factor, "delaying" on itself a certain share of MIF profitability, allows to obtain better clarification in order to explain the process of mutual funds' excess return generating, and its consideration in the construction of the appraisal model of the dive is somewhat reasonable.

CONCLUSION

Evaluation of the effectiveness of portfolio management of Russian investment funds is still poorly studied. Results of existing research in this field are not used in the Russian practice of evaluation and public disclosure of results of MIF portfolio management. Most often Russian managers use metrics, which don't allow an objective assessment of the effectiveness of portfolio management.

As part of this study, the traditional for a foreign practice metrics of the attribution approach were tested in terms of the assessment of managers' skills in micro-forecasting. The possibility of their practical use in order to assess the performance of investment portfolios of the Russian MIF is also shown.

We consider that the calculation of the considered metrics (possibly at the level of self-regulated financial market organizations) and disclosure of this data

as well, as the other officially published indicators of the MIF portfolio process, will help to reduce the level of uncertainty that arises around the activities of MIF management companies. Besides, we believe that this will positively affect the process of selection of funds for investment, which can cause a positive reaction from potential investors and lead to the development of competition in the Russian collective investment market to a qualitatively new level.

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