Validity of Fama and French Model on RTS Index*

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Abstract. The tools for estimating expected returns have advanced from mean-variance relationship to CAPM, a one-factor model that set the background for a more developed multifactor Fama-French model. Different developed and emerging markets were considered while testing the CAPM and the three-factor model. However, Russian capital market was lacking the Fama-French model test. This is a market with unique conditions of the transitional economy. The testing of the validity of the model on RTS was chosen as an objective for this research. With the dataset of 50 blue-chip Russian companies the results revealed that Fama-French outperforms CAPM on RTS index. Despite that, there are several limitations to the model due to the market inefficiency in Russia. This fact leaves arbitrage opportunities for investors.

Аннотация. Финансовые инструменты, позволяющие определить ожидаемые доходы, развились от простой взаимосвязи риска и доходности до CAPM и далее до трехфакторной модели. В процессе проверки моделей CAPM и Fama-French были изучены различные развитые и развивающие рынки, кроме российского рынка. Данный рынок находится в переходном состоянии, и тестирование модели Fama-French на индексе РТС было выбрано для исследования. По данным топ-50 компаний, в результате исследования было показано превосходство трехфакторной модели над CAPM на индексе РТС. Несмотря на это, существует несколько ограничений в модели из-за неэффективности российского рынка. Данный факт позволяет инвесторам использовать арбитражные возможности.

Key words: Fama-French model, RTSI, CAPM, expected-return, stock portfolio.

1. INTRODUCTION

In the world of finance, the estimation of expected returns and portfolio performance evaluation has always been a central issue for the academics and practitioners. The first major appearance of such technique was mean-variance relationship of the returns (Markowitz, 1952), followed by CAPM and the latest — widely recognized — Fama and French model. Fama and French three-factor model, which was initially set out in the fundamental Fama and French (1992) work, was a breakthrough in the financial world. It employed additional factors for size and book-to-market ratio. The tests on the developed markets followed with the majority of the studies done in the developed and emerging markets, which employed the success of the three-factor model. Still, there are some markets, which were not explored.

Russian stock market is one of the cases. It has the features of the emerging market; furthermore, there are signs of its transitional nature.

In 1992–1997, after USSR breakup, the market economy developed at unprecedented pace. The economic structure skewed towards the service sector, providing in official figures 41% for the industry and 51.5% for the service in 1995, whereas two years ago the figures favoured industry sector. In addition, the newly diversified economy was accompanied with the falling trend of GDP and inflation peaked at 2300% annually. Despite that, Russian market was appealing to the foreign investors because of its capacity and opportunities (Kvint, 1998).

Financial markets appeared in such conditions. Since 1992, MICEX (Moscow Interbank Currency Exchange) and RTS (Russian Trade System) have been the major national stock exchanges with $ 50 million traded every day back in 1998 (Kvint, 1998).

The stock markets appeared to be somewhat successful. So far, there were issues that constrained the foreign investors. The most problematic areas could be outlined as unavailability of the correct audited financial results that conform to international standards; refusal to allow shareholders to appear on board

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of the directors, despite law guarantees. Moreover, there were persistent non-disclosure of the trading deals, long periods of confirming the trades and, finally, restrictions of some stocks to be purchased only by Russians (*New York Times*, 1997).

Over the years, there was a significant improvement in the stock market governance and the foreign rating agencies' attitude towards Russian investment climate, according to Sollogoub (2003). For four years of high oil and gas, prices improved the Russian balance, but the economy was bound to the fossil fuel prices. In spite of the diminishing diversity of the economy, Moody's upgraded the country's rating by two notches to Baa[3] in 2003. By taking that unconventional step, the agency put national stock market in rather appealing condition, as well as the whole economy to continue improving. Still, there might be issues with the institutional aspects, as it appeared to be questionable in terms of governance (Sollogoub, 2003).

The global financial crisis revealed the problems of Russian economy. During the turmoil of 2008, MICEX and RTS plunged almost 54 percent along with oil price. Despite that, the government managed to respond quickly to prevent severe losses and to control unemployment with help of reserves. Banking system was also saved from collapsing. The Russian economy managed to sustain the crisis reasonably well (Guriev & Tsyvinski, 2010).

In 2014, Russia faced another challenge of the falling prices for the fossil fuels. Focusing on the oil and gas production, the drop in prices affected stock market as well as entire economy to shrink. The result of that was downgrading of the credit rating to near 'junk' level — Ba1 (Moody's, 2015). That might be the problem of the poor economy diversification.

So far, Russian emerging market has the process development of what have already been present on developed markets for some time, for example stock exchanges and companies' stocks. For some, the privatization appears to be the main challenge. Overall, there is highly probable form of market inefficiency.

2. LITERATURE REVIEW

The asset-pricing models were under constant development since the second half of the twentieth century. Finance practitioners and academics have been seeking better tools to predict the market as well as calculate the future cost of capital and measure portfolio performance.

The literature discussion starts with the Capital Asset Pricing Model (CAPM), which was developed by Sharpe (1964), Lintner (1965) and, consequently, Mossin (1966). This was a major breakthrough in determining the expected returns through risk-return relationship since the portfolio model was introduced by Markowitz (1952).

Markowitz's model operates under the assumption that investors want to minimize the variance of portfolio return and maximize the expected return, thus the model is known as 'mean-variance' model.

CAPM employs the central mean-variance relationship developed by Markowitz (1952). Sharpe (1964) and Lintner (1965) add two key assumptions to the mean-variance model: complete agreement on the asset returns distribution, the borrowing and lending is possible at risk-free rate. In addition, the idea market equilibrium was introduced, that there are common interest rate for investors and their expectations of the further market movements are the same (Sharpe, 1964).

CAPM employs transformation of algebraic statement of the 'mean-variance' model into the testable prediction of the relation between risk and expected return on markets in equilibrium. The formula for CAPM (1) can be incorporated in the following form by simple derivation (Jensen, 1972) from the original Sharpe-Lintner research.

$$R_m - R_f = \alpha_i + \beta\left[E\left(R_M\right) - R_f\right] + e_{it} \qquad (1)$$

Despite being viable in theory, CAPM failed to provide an empirical evidence that proves the success of the model. Through several tests on explaining excessive returns Black, Jensen and Scholes (1972), Fama and Macbeth (1973), and Fama and French (1992) revealed that the model did not succeed in the explanation of the excessive returns of the securities on market, as the security market line appeared to be too flat.

Fama and French (1992) argue that CAPM might be based upon rather unrealistic assumptions, as mean and variance over the one period. Researchers suggest that market beta misses significant dimensions of risk assigned to the labour income and future investment expectations. Through cross-sectional regression approach, the findings by Fama and French suggest that the use of size and book-to-market equity helps 'to absorb the roles of leverage and E/P in average stock returns' (Fama and French, 1992, p. 428). The book-to-market equity ratio has stronger explanatory power than size, but the book-to-market ratio cannot replace size in explaining average returns.

The same conclusions appear in following papers by Fama and French (1993, 1996) with use of time-series approach. The formula used in papers as introduced by Fama and French (2):

$$\begin{aligned} R_{it} - R_{ft} = \alpha_i + \beta_{iM}\left[E\left(R_{Mi}\right) - R_{ft}\right] + \\ + \beta_{is}E\left(SMB_t\right) + \beta_{ih}E\left(HML_t\right) + e_{it} \end{aligned} \qquad (2)$$

This model improved the CAPM by providing two additional factors that seem to explain the returns. SMB is the excess return on a portfolio of small stocks over a portfolio of large stocks, while HML is the excess return on a portfolio of high book-to-market stocks over a portfolio of low book-to-market stocks. Betas are the slopes in the multiple regression. If asset pricing is rational, size and BE/ME must proxy the risk (Fama & French, 1992).

Fama and French (1993) found that despite the size and book-to-market ratio are not the state variables, higher average returns on small stocks and high book-to-market stocks reflect unknown state variables that are able to price the undiversifiable risk in returns, left by CAPM model. Furthermore, according to Fama and French (1995) paper, the findings show that weak firms with prevailing low earnings tend to have high BE/ME and positive slope on HML and negative slope in case of strong firms with persistently high earnings. HML appears to capture the variation of the risk factor related to earnings performance. Coupled with SMB, there are two main conclusions that stocks with low long-term returns tend to have positive SMB and HML slopes and higher average returns. In contrast, the stocks with high long-term returns tend to have negative slopes on HML and low future returns.

The introduced model employed rather forceful techniques, which were a subject to critique in several studies. A paper by Kothary, Shanken and Sloan (1995) states that the substantial part of premium results from survivor bias. Data snooping appears to be the other issue, addressed by Black (1993) and MacKinlay (1995). Apart from that, the distress premium was claimed to be irrational as the results of investor over-reaction that lead to under-pricing of distressed stocks and overpricing of growth stocks (Lakonishok, Shleifer, & Vishny, 1994). Fama and French (1996) discussed the outlined problems and concluded that suggested improvements follow the initial results. However, there is a drawback that three-factor model could not explain the momentum effect that leaves persistence of short-term returns unexplained.

In response, a research by Carhart (1997) claimed, that three-factor model might be improved, by adding the momentum coefficient. The study included tests of the three models: CAPM, three-factor model and the new four-factor model, introduced by Carhart (3).

$$R_{it} - R_{ft} = \alpha_{iT} + \beta_{iT} RMRF_t + s_{iT}\left(SMB_t\right) + \\ + h_{iT}\left(HML_t\right) + p_{it} PR1YR_t + e_{it} \qquad (3)$$

This model accommodates primarily two previous studies by Fama and French (1993) and Jagadeesh and Titman (1993). The latter study introduced the momentum factor (interpreted by Carhart as PR1YR), which captures the one-year anomalies. Through the tests, it was uncovered, that the four-factor model significantly improves CAPM as well as three-factor model. The four-factor model reduces the average pricing errors. It might be compared by actual figures: 0.35% for CAPM, 0.31% for Fama-French model and 0.14% for the Carhart model (Carhart, 1997).

In response to the Carhart research and the inability of the three-factor model to explain persistent short-term returns, Fama and French (2004) accept that lack of momentum effect as the main drawback. They, however, suggested that the sensible application of Carhart model appears to be achieving a goal of uncovering information and manager-specific effect free of known pattern in average returns. Moreover, Fama and French argue, that due to the short life of momentum effect it is likely to be irrelevant for estimates of the cost of equity capital.

Thus, Fama and French (2015) did not include the momentum in their five-factor model, as it is likely to affect the diversification of some of the portfolios used to construct the factors. This model employs another two additional factors based on the evidence of Novy-Marx (2013) and Titman, Wei and Xie (2004). These factors are profitability (RMW) and investment (CMA) and they follow the motivation that three factors of the original Fama-French model might miss the variation of the profitability and investment factors. The formula for the introduced model is following (4):

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}\left[R_{Mt} - R_{Ft}\right] + s_i SMB_t + \\ h_i HML_t + r_t RMW_t + c_i CMA_t + e_{it} \qquad (4)$$

As a result the Fama and French paper reports that the explanatory ability of the model somewhat improved, capturing from 71% to 94% of cross-section variance in expected returns. However, there could be capturing of the low-average returns on small stocks that mimic the high-volume investing companies despite the low profitability. In addition to this limitation, the HML factor might become redundant as its variations are captured by the two added factors (Fama & French, 2015). Still, the paper is new, and the tests are to be conducted.

To sum up, there is still no perfect solution in explaining the return on the stock markets. The development of the theories from mean-variance to five-factor model over last decades creates better explanatory results and diminishes the limitations of the predecessors. However, Fama and French (1996, 2004) claim, that their creation is just a model and it cannot be an ultimate tool for explaining all stocks and portfolios.

FAMA-FRENCH MODEL TESTS

On the developed markets, significant amount of tests were conducted, which provided different results on explanatory ability of the Fama-French model. Despite that, it could be argued, that three-factor model is more likely to be successful.

Initially, Fama and French were the first to carry out the tests of the model in 1992. The research aimed to test the validity of their model on the Northern American stock markets (NYSE, AMEX and NASDAQ) throughout the period of 1962–1990. Only non-financial firms were included in analysis in order to provide the consistent results. The result of their study unveiled that the three-factor model proved to capture the variations associated with size and book-to-market equity (Fama & French, 1992). Fama and French claimed that there might be a chance of the practical application of the developed model as it showed the systematic patterns of low BE/ME firms to be relatively better earners comparing to high BE/ME firms.

The investigation on the same markets was revisited by Lam (2005). This study compares CAPM to Fama-French model in ability of describing the market anomalies. The comparison is conducted on 25 portfolios formed on size and book-to-market ratio and 30 portfolios, shaped by industries. These portfolios were created on NYSE, AMEX and NASDAQ stocks throughout time periods: 1926–2004 and 1963–2004. The ordinary least square linear regressions econometric technique was used. The research produced questionable results, as three-factor model could not explain market anomalies on the 1963–2004 time period for 30 industries. This paper also reveals that Fama-French three-factor model might be portfolio specific, test specific as well as period specific (Lam, 2005).

The study by Hussain, Toms, & Diacon (2002) provides an accurate test on London Stock Exchange, similar to original Fama-French (1996) paper. Despite the differences in database, slightly different grouping of variable, the research provides strong evidence in favor of the Fama French three-factor model over CAPM. The R-squared is 0.59 and 0.83 for CAPM and Fama-French model respectively on average of the 25 regression (Hussain *et al*., 2002).

Another research is conducted by Faff (2004) on a rather remote developed market. This paper tests the Fama-French model on the Australian stock market. The researcher argues that although this market is small, it is developed enough to provide adequate results for three-factor model test over the dataset from 1996 to 1999 on approximately 320 Australian companies. This paper provides quite favourable results for the validity of Fama-French model. However, the validity deteriorates when the estimated risk premia is considered, leaving the negative size premiums uncovered. In addition, there is a concern in the study about the data snooping and reliance on the index data from Frank Russell Company (Faff, 2004).

In summary, the evidence from developed markets favours the three-factor model and follows the Fama and French (1992, 1993, and 1996) papers.

FAMA-FRENCH FEATURES OF EMERGING MARKETS

Emerging markets present an opportunity to conduct out-of-sample test of the model. According to Fama and French (1998) on the emerging markets the significance of BE/ME and returns relationship persist. That confirms the pervasive nature of the value premium and follows the evidence from the developed markets. The size effect could be observed in emerging market returns, as small stocks possess higher average returns than the big stocks in eleven out of sixteen of the markets analysed. However, the research shown high volatility on the markets and short sample period, which diminishes the ability of the study to produce accurate results.

The empirical tests conducted by other researchers on the emerging markets produced controversial results. The study by Eraslan (2013) revealed limited explanatory power to explain excessive returns of stocks listed on ISE (Istanbul Stock Exchange) from 2003 to 2010. The similar result is produced by another research (Soumare, Amenounve, Meite, & N'Sougan, 2013), which revealed limitations of three-factor model on explaining the BRVM market returns on African market throughout the 2001–2008 period. In contrast, the results from Karachi stock exchange (Rafi, Kazmi, & Haslim, 2014), stock exchange on Mauritius (Bundoo, 2008) uncovered the validity of the three-factor model on these markets.

The studies were carried out mostly using the Fama-French (1993) sorting technique, with deviations in order to meet the country specifics. For instance, in the research employed on the BRVM (Soumare, Amenounve, Meite, & N'Sougan, 2013) median market capitalization was used as the breakpoint for the size, and the 30th and 70th percentile as benchmark to distinguish book-to-market values into three categories of the companies. It appeared slightly different in the research on Mauritius stock market (Bundoo, 2008), which distinguished only two classes of book-to-market ratio on median value. This approach was more suitable due to the smaller sample size.

The research by Eraslan (2013) on Istanbul stock market was made on the similar methodology to Fama and French (1996). Firms were allocated in three groups by the low 30 percent, medium 40 and

high 30 percent on every variable. Then, nine portfolios were constructed from 274 stocks and were sorted into six portfolios. The results were that medium size portfolios tend to outperform the portfolios of smaller sizes, although, it seems to be unsatisfactory to assess big size portfolios. Moreover, it could be noted, that the conducted study carried less power to assess the validity of the discussed model in comparison to the others, being done on the ISE. That may be explained by the different time periods, number of stocks in the portfolio, and by the inclusion of global financial crisis in the analysed period (Eraslan, 2013).

Almost the same result appears in another research that considers African stocks on BRVM over the period from 2001 to 2008. The correlation between emerging African market and the developed markets is low. Thus, the research aims to find an explanation of the stock returns in light of market imperfections, such as poor governance structure, inadequate investor protection etc. This study presents that Fama-French model explains returns for 10 out of 28 stocks, or 35.71%; so there appears to be limitations for the validity of the discussed model (Soumare *et al.*, 2013).

The limitations of three-factor model were unveiled in the study on Karachi stock exchange market. The research showed limited results in favour for the Fama-French model (Rafi, Kazmi, & Haslim, 2014) on the KSE-100 in the period of 2011–2013 on 100 companies, sorted by the same technique as implemented by Fama and French (1992). The results of the research shows that the three portfolios valid for the market risk premium, four for the size premium and three portfolios valid for all factors. However, it could be argued, that the three-factor model might not be able to successfully describe the excessive return in the KSE-100 index, as four out of six portfolios possess insignificant results to their intercepts.

In contrast to previously discussed papers, the study by Bundoo (2008) investigates the validity of the Fama and French on SEM (Stock Exchange of Mauritius). The research takes into account 40 stocks, from the period from 1998 until 2004. Number of the companies varied from 6 (1998) to 40 (2004). The author implemented the augmented three-factor model, which considers time-variance factor. The result of this paper produces the evidence of the validity of Fama-French model on the SEM. That also brings in the empirical evidence on emerging markets.

In Eastern European emerging markets, the research conducted by Foye, Mramor and Pahor (2013) addresses the issue of probable data mining rather than appropriate proxy for risk for the three-factor model since its origin in 1992. The discussion of this issue is influential in European nations with emerging market that joined the EU in 2004 (Foye *et al.*, 2013). This research tests the validity of the model on stock market in several countries: Poland, Hungary, Czech Republic, Slovenia, Slovakia and Baltic countries over the period 2005–2012. Through the work, the researchers found three-factor model to follow the results of Fama and French (1993) paper for book-to-market ratio factor, whether for size the slope coefficients appeared to be negative and of low explanatory ability.

These results corroborate the earlier study by Claessens, Dasgupta and Glen (1995) which provides the evidence that size effect could not be fully reliable in explaining the market returns, as only eight out of nineteen emerging markets produced the highest rate of stock portfolio returns. In addition, it revealed the highest standard deviation, which the market returns seem not to be related to the size and inaccurate predictions.

Foye *et al.* (2013) provided extension for the Fama and French (1998) and Claessens *et al.* (1995) findings and instead of size factor suggested using the LMS coefficient based on NI/CFO, or net income to cash flow from the operations. This factor does not support the investors with relevant information about the company's performance, however, it still might be useful for indicating the 'earnings quality' (Foye *et al.,* 2013, p. 15) and accounting manipulation. The investors might evaluate the differences between net income and cash flow from operations as being associated with accounting manipulation. Thus, the proposed coefficient might represent the risk factor (Foye *et al.,* 2013).

By using the new factor, the study produced better results, comparing to the three-factor model. The NI/CFO factor returns appear to provide significantly higher R^2 values than the model employed market equity factor. The figures of adjusted R^2 are on favour for the NI/CFO (0.13) rather than for ME (0.03). In addition, with the new factor employed, the direction of the regression slopes does not change considerably, whether the slope coefficients for the ME are negative for the low-ME (from –0.51 to –0.81) and positive for the high-ME (0.72–1.15) (Foye *et al.*, 2013). It appears that proposed factor presented better explanatory power to the eastern European stock markets. However, this model is new and the initial research was conducted on the number of countries, whereas this article focuses only on one country. Thus, the developed model by Foye *et al.* (2013) might to be rather unsuitable for the current research paper.

Generally, the tests of three-factor model on emerging markets follow the results from developed markets, providing the same BE/ME effects and rather

limited size effect. The limitations might be related to the short time periods or sorting method.

RUSSIAN STOCK MARKET

Russian market is one of the largest among the emerging market countries because of large territory, high capacity and high market capitalization. However, it is still in transition to the conventional market economy. This process involves specific challenges and Russian stock market might share the discussed problems of emerging markets. Yet, there could be unique risk factors that influence the market performance.

A paper by Goriaev and Zabotkin (2006) investigates the risks assigned to the Russian stock market in first decade after it was created. Started from a scratch in 1994, the Russian stock market had a total capitalization over $ 600 bn or 80% of GDP at the end of 2005. As authors claim, this result was achieved after resolving two important challenges.

The first challenge is macroeconomic stability that was influenced by the recovery of oil price and prudent fiscal policy. The second challenge is a political stability assumed by Putin's legitimacy and popularity. His meeting with business leaders in 2000 resulted in settlement of the incentives for the corporate governance. This appeared to be a turning point after the privatization process, as these incentives improved security of major companies' assets in Russia. Thus, the business owners were given an interest in both maximizing and protecting their wealth and improved reputation.

As Goriaev and Zabotkin (2006) observe RTSI's performance over the first decade, when the discussed issues were addressed, the overall progress of transition persisted. The evidence of this was the creation of value in companies in the commodity-exporting sectors, dominated in the economy, and the emergence of the new business that was consumer-oriented and could not exist in USSR (Goriaev & Zabotkin, 2006). Goriaev and Zabotkin (2006) claim that short-run movements in Russian stocks might be linked to the fluctuations in domestic and international markets, including commodity markets (crude oil in particular), global equity markets and foreign exchange.

It was a period of development of stable links with macroeconomic variables during 1995–2004 and overall maturing of the market; however, the study by Anatolyev (2005) argues that Russian stock market became more sensitive to global factors, such as the U.S. stock market performance and interest rates. The study by Peresetsky (2014) provides evidence that Japan market is more significant to Russia at least over the period 2000–2010. This is because the closures of the Russian and Japanese markets are close to each other in time, whether the US market is too far. Peresetsky (2014) claims that NIKKEI index contains more relevant information, which might possess predictive power for the Russian equity market.

Other driver — oil price — plays important role in Russian economy, and it might influence the stock markets as oil price expectations in long-term are gradually reassessed, whereas interim oil price volatility has a secondary importance on the emerging markets. A paper by Rozhkov (2005) states that about 60 percent of RTS index's performance is determined by oil prices, in other words, 60 percent is allocated to oil producers. It can be argued that oil price might be evaluated as the most important market driver and it also carries a large risk (Rozhkov, 2005). However, another research by Peresetsky (2014) of market drivers on the period of 2000–2010 unveiled the vanishing significance of oil prices for the stock market after 2006. This conclusion might be considered rather controversial in light of the latest events. The drastic drop in oil prices depreciated rouble and hence created inflation in economy (*The Economist*, 2014).Then the capital market shrank to total capitalization of $ 531 bn, which is less than a market capitalization of Apple — $ 669 bn (Tadeo, 2014).

The final factor is foreign exchange rate, which contributed, according to Goriaev and Zabotkin (2006), to the growth of the RTSI. The estimated coefficients for RUB/USD were significant by 21% and for USD/EUR by 34%. The impact of foreign currencies' rates appeared to be the most evident from 2000 to 2005. As a result, the exporting companies seemed to get the largest benefit (Goriaev & Zabotkin, 2006). Similar results were obtained by Saleem and Vaihekovski (2008), who found currency risk to be a separate risk factor on Russian stock market over the period 1995–2006. In contrast, the study by Kinnunen (2012) unveiled little explanatory power for the expected return on the Russian market through application of conditional multifactor and autoregression model over period 1999–2012.

All in all, the Russian stock market has a predictable volatility in different sectors of economy, claims the study by Saleem (2014) on period of 2004–2013. Using FIGARCH model, the paper establishes stock market long memory in all sectors of the Russian capital market, which moves to the implication that the modern Russian equity market is weak form efficient. This results are consistent with the earlier work by Anatolyev (2005), which also found Russian market instability to be not confined to the financial crisis. Saleem (2014) concludes on the need of regulatory and economic reforms within national financial system. So far, there are arbitrage opportunities for international investors.

OBJECTIVE

This article aims to test the Fama and French three-factor model on Russian stock index RTS. Given the challenging environment of this market, associated features, and lack of literature investigating the Fama-French model on Russian equity market, the research on it would enrich the overall evidence from the promising emerging markets. Apart from that, that would help finding the ability of the three-factor model to explain the Russian market.

RTS is fundamental market index calculated on prices of the 50 most liquid Russian stocks of the largest and dynamically developing Russian issuers presented on the Moscow Exchange. RTS Index was launched on September 1, 1995 at base value 100. It is calculated in real time and denominated by Moscow Exchange in US dollars, which is an adjustment of MICEX index values by the current exchange rate. The market capitalization was $ 116 bn by the end of 2014 (Moscow Exchange, 2015).

Motivation of the research to investigate this particular index is the US dollar denomination that makes this index interesting for the foreign investors, as it would provide rather clear picture of the current situation in Russian economy.

3. METHODOLOGY

The preferred method of the research still would follow Fama and French techniques, as it investigates the emerging type of market in a country with its own features, where three-factor model was not tested previously. This research would implement the process of portfolios construction that follows the Fama-French (1993) approach. There are three factors in the model equation that should be provided with appropriate data.

$$E(R_{it}) - R_{ft} = \alpha_{it} + \beta_{iM}\left[E(R_{M_t}) - R_{ft}\right] + \\ + \beta_{is}E(SMB_t) + \beta_{ih}E(HML_t) + \varepsilon_{it}$$

The first factor $[(R_{Mi}) - R_{fi}]$ acts as proxy to the excess market portfolio return. RTS index is used as this proxy. The second factor is small minus big (SMB), which provides the difference in returns between a portfolio of small stocks and a portfolio of big stocks. The final factor is high minus low (HML), which represents the difference between high book-to-value (BE/ME) stocks and low book-to-market value (BE/ME) stocks. To avoid any confusion, the small and big are associated with the market equity (ME) which is the total shares on the market and the share price. The low and high relate to the book-to-market value that shows the relation between the book value and market value of the share. Book value is the accounting measure of 'net worth of the company as reported on its balance sheet' (Bodie, Kane, & Marcus, 2011).

The following step would be to create portfolios from the combination of the market size and book-to-market value. That would be implemented by sorting RTS stocks independently in the two size groups (low and high) and three book-to-market equity (BE/ME) groups: low, medium and high (L, M and H). The breakpoint for the size would be a group median of the dataset. The breakpoints to distinguish the BE/ME groups would be 30th percentile for low and 70th percentile for the high. The middle group would be situated in-between 30th and 70th percentiles accordingly. Finally, there would be six portfolios created on the intersection of the two market equity groups and three book-to-market value groups. These portfolios would be S/L, S/M, S/H, B/L, B/M and B/H.Each of these portfolios should have stocks that could be attributed to the both categories, e.g. high BE/ME and small size stock would be placed in the S/H portfolio.

ESTIMATION OF EXCESS RETURNS

The excess returns would be sourced by all three factors (market, SMB and HML). The excess market return is estimated by the difference between market return (with dividends) of the RTS index and the risk free rate with the following formula $[(R_{Mi}) - R_{fi}]$, estimated for each month. RTS index return is calculated using formula below:

$$Market\ Return = \frac{Close\ price_t - Close\ price_{t-1}}{Close\ price_{t-1}}$$

The R_{fi} factor is the return of 10-year Russian government bond, collected from Bloomberg database (Bloomberg L.P., 2015).

After market return estimation, the following procedures of forming SMB and HML factors should be carried out. There are six portfolios, (S/L, S/M, S/H, B/L, B/M and B/H) which are filled with appropriate companies. The next step is to calculate the returns during the period of observation in each group of stocks with the following technique. Every month the return of portfolio is estimated as an all-stock average return of that period. This process is carried out every year of observation period across all constructed portfolios.

The following step would be estimation of SMB and HML factors. According to the Fama and French (1993) study, the following formulas below should be employed in calculations.

$$SMB = \frac{(S/L + S/M + S/H)}{3} - \frac{(B/L + B/M + B/H)}{3}$$

For each month SMB is the difference between the averages of returns on three small-stock portfolios (S/L, S/M, S/H) and three big-stock portfolios (B/L, B/M and B/H).

$$HML = \frac{(S/H + B/H)}{2} - \frac{(S/L + B/L)}{2}$$

As for HML, the process appears to be similar. For each month HML is the difference between average returns on two high book-to-market value portfolios and two low book-to-market portfolios.

Described techniques have some limitations, as accepted by Fama and French (2004). SMB and HML factors would rather be forcefully constructed and appear not to be naturally involving investors' interest. The study by Michou *et al.* (2007) discovers the link between portfolio construction design and the estimation outcome. Thus, the results of this article are largely influenced by the factor construction design.

Despite that, the SMB and HML factors still might be useful, as they would describe the stock factors to be explanatory with size or book-to-market value.

The following step would be a multiple regression analysis that involves the ordinary least squares approach. The dependent value is the excess return of one out of six portfolios and the independent values are market returns, SMB and HML. All coefficients that would appear next to the factors should be able to mathematically explain the excessive returns inside the Fama-French model. In order to define the statistical significance the autoregression and heteroscedasticity tests would be carried out.

HYPOTHESES

Finally, there are the hypothesis tests with presumptions that the RTSI possesses the market, size and book-to-market effects; the test is robust and three-factor model works better that the conventional CAPM. The decision on accepting or rejecting the hypothesis is based on meeting the objectives set out previously.

Earlier papers have conducted the test of the Fama-French model on markets, which differed in terms of location and types. There appears to be a gap in constructing and testing the three-factor model on the Russian stock market, which this paper aims to fill due to its features and differentiation from other emerging markets.

Therefore, the main question of this research is how efficient the Fama-French model is in explaining the stock returns on the companies-constituents of RTSI index.

By testing the validity of the model, the process of its application would be followed by the hypotheses.

The **hypothesis 1**: There is a market, size and book-to-market effects on RTSI. Null hypothesis H_0: the coefficients of the three factors (market, size and book-to-market risk factor) equals to zero (β_{iM}, β_{is}, $\beta_{ih} = 0$). Alternative hypothesis H_1: the coefficients of the three factors is different from zero (β_{iM}, β_{is}, $\beta_{ih} \neq 0$).

The **hypothesis 2**: Fama and French three-factor model is robust on RTSI. Null hypothesis H_0: the coefficients of the three factors (market, size and book-to-market risk factor) equals to zero simultaneously (β_{iM}, β_{is}, $\beta_{ih} = 0$). Alternative hypothesis H_1: there is at least one coefficient of the three factors, which is significantly different from zero (β_{iM}, β_{is}, $\beta_{ih} \neq 0$).

The **hypothesis 3**: The Fama and French three-factor model is better than traditional CAPM model in describing the expected returns of the portfolios. Null hypothesis H_0: the Adjusted R-Square of Fama-French three-factor model and CAPM are not statistically different. Alternative hypothesis H_1: the Adjusted R-Square of Fama-French three-factor model is greater than that of CAPM model.

The **hypothesis 4**: Fama-French model is efficient in explaining the excess returns on RTS index. The null hypothesis H_0: the intercepts of regression model are equal to zero or insignificantly different from zero ($\alpha_{it} = 0$). The alternative hypothesis H_1: the intercepts of regression model are different from zero ($\alpha_{it} \neq 0$).

4. RESULTS

The estimation results are corrected for autocorrelation and heteroscedasticity using Breusch-Godfrey LM test and White test respectively. The results of both tests are summarized in the following Table 1.

The results present that two portfolios could be considered to have heteroscedasticity phenomenon — S/M and B/M portfolios. B/M deviates rather insignificantly from the critical value, but still in area of null hypothesis, whether the S/M portfolio has a large difference. Thus, the S/M portfolio's model should be reconstructed, followed by the regression analysis, while B/M portfolio might be accepted to have homoscedasticity.

For the majority of observed portfolios, the LM test has shown no sign of autocorrelation. Only for S/H portfolio for CAPM, the autoregression test revealed the negative correlation of errors. According to (Tabachnick & Fidell, 2013) it makes the estimates

Table 1. LM and White's Test Results.

White's test			Breusch-Godfrey LM test	
Portfolio	Fama-French	CAPM	Fama-French	CAPM
S/L	0.9354	**4.2385**	0.5576	0.4021
S/M	**10.6971**	0.0136	1.7844	0.3699
S/H	0.1094	6.5199	2.8501	**6.6677**
B/L	2.7014	0.0787	3.2029	1.522
B/M	0.2404	2.6339	2.2133	5.0884
B/H	1.9095	1.4208	3.1549	1.9095
Critical chi-square value	**2.71**		**9.49 (5%)**	**5.99 (5%)**
			13.28 (1%)	**9.21 (1%)**

too large, and results in loss of power. Thus, the regression procedure associated with the S/H portfolio should be modified to remove the effect of autocorrelated errors.

Overall, the verification process unveiled the issues with S/L, S/M and S/H portfolios that should be resolved by appropriate methods.

Because of the corrections and consequent estimation, the regression statistics with homoscedasticity and without autoregression are summarized below (Table 2). However, for CAPM the heteroscedasticity persists even after adjustments.

SMB and HML correlation is 0.217556, which shows the effective portfolio construction.

TESTING HYPOTHESES

After establishing that the collected data is reliable, the hypotheses could be addressed.

The hypothesis 1: There is a market, size and book-to-market effects in RTSI.

A t-test statistic could help finding the answer to this hypothesis. In the regression model the independent variables were market return risk, size and book-to-market value factors; the dependent variable are 6 portfolio returns (S/L, S/M, S/H, B/L, B/M, B/H) used one by one in each iteration. The results of regression analysis are summarized in the Table 3 below.

It could be observed that all risk factors slopes are different from zero, so the null hypothesis could be rejected. As a result, there are market, size and book-to-market effect to be on RTS index.

Interestingly, the market risk factor slopes hold the level of significance at 1% across all six portfolios. Moreover, it could be observed that the figures of β_{iM} do not differ significantly from 1. That appears to be the evidence of additional factors, as Fama and French (1993) claimed. SMB and HML hold somewhat explanatory power on RTS index.

The size slope for SMB factor provides rather controversial results. Only three out of six portfolios (S/L, S/M, S/H) provide positive results with the significance level of 1%. The slope for B/L failed the significance test; the B/M portfolio has shown the significance at 10% level and β_{is} coefficient for B/H appears to be the most accurate with 1% significance. However, all three portfolios with big size stocks appear to be negative, which means lack of the size effect for them irrespectively of level of significance. Thus, there is clear evidence that there is size effect present on RTSI for portfolios with small size stocks, and there is no size effect for portfolios with big size stocks.

Finally, a book-to-market value risk (HML) factor also possesses controversy in the obtained results. Only three portfolios (S/M, S/H, B/H) have positive results with level of significance of 5%, 1% and 1% respectively. Others (S/L, B/L) possess negative figures with 1%, 5% significance levels, while the result for B/M is not significant even for 10% level. Thus, it could be argued, that the book-to-market value effect is present only in three out of six portfolios.

However, in spite of that, it can be claimed that the behaviour of stocks cannot be explicitly explained. The evidence of that is that the regression coefficients are higher for the S/H than for B/H, whereas the implication is made on opposite (B/H > S/H). This means lack of powerful explanation of book-to-value effect, which seems to work efficiently only for the high book-to-market portfolio. In addition, the impact of book-to-market value on excess returns has unsystematic behaviour in the observed portfolios.

To conclude, the market factor appears to be statistically significant at 1% level across all observed portfolios. The SMB factor has proved the presence of size effect on RTSI only for the portfolios of small

Table 2. Adjusted Regression Estimation.

Adjusted Regression Results						
Fama-French					CAPM	
Factors	α_{it}	β_{im}	β_{is}	β_{ih}	α	β_{im}
S/L	1.1303***	1.0030***	0.7128***	−0.8329***	−2.039***	3.334***
S/M	−0.1960	0.8861***	1.1999***	0.2139***	2.819**	1.144***
S/H	0.1579	0.9752***	0.9293***	0.6837***	4.554***	1.117***
B/L	0.3083*	0.9942***	−0.0143	−0.1600**	−0.174	0.995***
B/M	1.0841*	1.0186***	− 0.1915*	−0.0442	0.82	1.000***
B/H	1.2807*	1.0220***	− 0.2308***	0.3234***	2.075***	0.996***

*	Significant level of 10%
**	Significant level of 5%
***	Significant level of 1%

White's test		
Portfolio	**Fama-French**	**CAPM**
S/L	0.9354	**7.7484**
S/M	1.1699	0.01362
S/H	0.1094	**6.5199**
B/L	2.7014	0.0787
B/M	0.2404	2.6339
B/H	1.9095	1.4208
Critical chi-square value	2.71	

Breusch-Godfrey LM test		
	Fama-French	**CAPM**
S/L	0.5576	0.4021
S/M	1.7844	0.3699
S/H	2.8501	0.6079
B/L	3.2029	1.5220
B/M	2.2133	5.0884
B/H	3.1549	1.9095
Chi-square	9.49 (5%)	5.99 (5%)
	13.28 (1%)	9.21 (1%)

size stocks, while excessive returns associated with the big size portfolios appear to have no relationship with size effect of Fama-French model. As for the HML factor, the results follow the Fama and French (1993) study as three out of six portfolios (S/M, S/H, B/H) provide positive and statistically significant (5%, 1% and 1%) slopes. It is reasonable to claim, that the model works well in explaining excess returns on RTS index after the global financial crisis in 2008.

The following hypotheses would be addressed simultaneously, as they share practically similar statistical approach.

The hypothesis 2: Fama and French three-factor model is robust on RTSI.

Table 3. Corrected Fama-French Model Regression Coefficients.

Fama-French Coefficients				
Factors	α_{it}	β_{im}	β_{is}	β_{ih}
S/L	1.1303***	1.0030***	0.7128***	– 0.8329***
S/M	–0.1960	0.8861***	1.1999***	0.2139***
S/H	0.1579	0.9752***	0.9293***	0.6837***
B/L	0.3083*	0.9942***	–0.0143	– 0.1600**
B/M	1.0841*	1.0186***	– 0.1915*	–0.0442
B/H	1.2807*	1.0220***	– 0.2308***	0.3234***

The hypothesis 3: The Fama and French three-factor model is better than traditional CAPM model in describing the expected returns of the portfolios.

Hypothesis 2 implies robustness test of the three-factor model, which will be carried out by comparing the produced p-values for the observed portfolios. In order to minimize the probability of type II error, a significance level at 5% (0.05) would be chosen. As presented in Table 4 the p-values across all portfolios are lower than 0.05. Thus, the null hypothesis should be rejected, which means the robustness of the model on RTSI.

The hypothesis 3 aims to compare two models' explanatory ability on the discussed market. The p-values for both models favour their statistical significance, but there is a major distinction in terms of R^2. It appears to be higher for Fama-French model than for CAPM in every portfolio. In addition, the R^2 are substantial and do not vary greatly (86% — 94%), while CAPM is more inconsistent (43% — 90%). On average, it can be observed that Fama-French model explains 91% of excess returns compared to 75% of returns explained by CAPM. Hence, the null hypothesis might be rejected straightaway for the market in discussion.

In addition, the final **hypothesis 4** should be considered that Fama-French model is efficient in explaining the excess returns on RTS index. It is common implication that the model performs well in explanation of the excess return, if the intercept is zero or deviates from it insignificantly. That would mean that the pricing error of such model is subtle or relatively low. The intercept comparison is presented below (Table 5).

The results provide ambiguous results. Clearly, it can be observed that Fama-French on average possesses lower pricing error than CAPM, 0.6275 and 1.3425 respectively. In addition, the half of observed intercepts is higher for Fama-French than to CAPM in corresponding portfolios. Only in three instances, CAPM outperforms the Fama and French model. For the S/L portfolio the intercepts for CAPM and Fama and French are –2.39 and 1.1303; for B/L portfolio are 0.3083 and –0.1741; and for B/M portfolio are 1.0841 and 0.8201. Interestingly, the same portfolios hold the negative figure for HML factor. Thus, intercepts might explain that book-to-market risk factor is absent for these three portfolios. In addition, the higher values of intercepts for these portfolios might be explained as the result of minimization of HML slope impact on the regression model.

Table 4. Regression Statistics for CAPM and Fama-French model.

	R squared		F-Statistics		P-value	
Factors	**Fama-French**	**CAPM**	**Fama-French**	**CAPM**	**Fama-French**	**CAPM**
S/L	94%	75%	346.611	208.402	0.00000	0.00000
S/M	90%	43%	113.510	148.978	0.00000	0.00000
S/H	93%	72%	311.552	129.542	0.00000	0.00000
B/L	89%	88%	182.433	519.778	0.00000	0.00000
B/M	86%	85%	137.601	391.692	0.00000	0.00000
B/H	93%	90%	310.675	600.156	0.00000	0.00000

Table 5. Intercepts for Regression Models.

Intercepts		
	Fama-French	CAPM
S/L	1.1303	–2.039
S/M	–0.1960	2.819
S/H	0.1579	4.554
B/L	0.3083	–0.174
B/M	1.0841	0.820
B/H	1.2807	2.075

In contrast, the S/H portfolio appears to be the most successful in explaining excess return, as the intercept's difference from zero might be claimed to be relatively insignificant, comparing to the others. Furthermore, as it was discussed earlier, the S/H portfolio holds positive slopes for risk factors with the significance at level of 1%. Moreover, by analysing the intercept, it can be concluded that S/H portfolio is the most successful example of Fama and French model on RTS index.

In summary, the hypothesis 4 should be answered with the alternative hypothesis H_1 that the intercepts of Fama-French model regressions are not equal to zero.

FINDINGS

Considered hypotheses provided the results that can evaluate how efficient Fama-French model is in explaining the returns of stock on RTS index. The outcome of the regression analysis provided limited explanatory power of Fama-French model on RTS index, as the intercepts of the regressions are significantly different from zero for 3 out 6 portfolios. Apart from that, there are size effects for small-stock portfolios and BE effect for S/M, S/H and B/H portfolios. The results are controversial and there is rather unsystematic behaviour of factors on market. That is another limitation for the Fama-French model on Russian market. However, it might be accepted that three-factor model is successful on the Russian market, as it presents larger average R^2 comparing to the result of CAPM (91% to 75%), and it has the strongest explanatory power for 3 out of 6 portfolios (S/M, S/H, B/L).

The findings of this study are similar to the conclusions from several earlier papers from emerging markets. Study by Eraslan (2013) also finds the limited explanatory power of Fama-French model on ISE, as it omits the systematic behaviour of HML and SMB limit in explain big-size portfolios. Another research by Soumare *et al.* (2013) has found that the Fama-French model outperformed CAPM on BRVM market, which is similar to the current research findings. On BRVM, three-factor model explanatory power appeared to be limited as it failed to explain the variation of returns of more than 60% of stocks. The findings by Al-Mwalla & Karasneh (2011) on Amman Stock Exchange are also close to the those from RTS index. CAPM loses to Fama-French model in explanatory power. And, finally, the evidence from Pakistani stock market (Hassan & Javed, 2011) appeared to be the closest, as high BM stocks outperform low BM stocks, as well as the inconsistency is also presented in size effect.

The limitations of size factor on RTSI follow the research papers by Claessens *et al.* (1993, 1998). These studies reported that in emerging markets the market equity factor has less explanatory ability than in developed capital markets. Fama and French (1998) also found this limitation, but despite diminished role of SMB factor, the book-to-market ratio has significant relationship with returns. That is partly true for the Russian capital market, as book-to-market value factor is present in half of observed portfolios but inconsistent.

5. CONCLUSION

The Russian stock market seems to be promising but it is rather unstable. This instability appeared not to be driven only by the financial shocks. The discussed risk drivers provide evidence, that the volatility of the Russian equity market has long memory, and it has weak form efficiency, which leads to arbitrage opportunities for foreign investors.

Fama and French three-factor model was broadly tested both on developed and emerging markets. However, the Russian capital market was lacking the application of this model. As other emerging markets, the Russian market has weak-form efficiency. Moreover, this challenging condition makes it a good area to test the validity of the three-factor model.

The results from estimation appeared to be favourable for three-factor model, as the additional two factors of Fama-French model seem to improve the explanatory ability of the traditional CAPM. The Fama-French model is presented on Russian stock market with size and book-to-market effects, however, the behaviour of the stocks of different size and BM ratio is rather unsystematic. Despite that, the three-factor model is robust, as all factors are different from zero, and it performs better than the conventional Capital Asset Pricing Model by comparing average R^2 figures for the observed portfolios. Furthermore, the intercepts' figures appeared to be rather ambiguous. The regression model, that was applied to test the model, employed significant positive slopes, which is an evidence of adequate regression application. Overall, the model appears to be valid only for 3 out of 6 portfolios, which is a limited success of the model but consistent with papers on testing three-factor model on other emerging markets.

The limited validity of the model would resolve in conclusion, that size and book-to-market ratio might be proxies for risk on a particular market. Hence, there is an implication that average returns compared to historical average benchmark have limitation in evaluating managed portfolios as well as estimating expected returns. The possible explanation of this is weak-form efficiency of the Russian capital market. In this case, the persistence of the results is more likely to be suspicious (Fama & French, 1992). Certainly, the efficiency of the Fama-French model on RTS is limited. Three-factor model still might be used to evaluate portfolio performance; however, it would not absorb all risk factors efficiently. As it was stated above there is a room for arbitrage opportunity, thus investors might try beating the market.

The received results might also be subjected to the shortcomings of the research design. One of the possible limitations of this research is sorting method, which greatly influences the outcome of the study, according to Michou *et al.* (2007). The other is the date of portfolios formation, which also has an impact on the results of the study (Michou *et al.*, 2007). Moreover, the article was focused on RTS index, which is constituted by 50 'blue chip' stocks, omitting other equities present on Russian capital market. Finally, article considered the RTS index involved USD/RUB exchange rate, which might have influenced the real movements of the market, thus distorting data for the Fama and French model.

Further work on Russian stock market might involve application of the same three-factor model using different sorting technique and including more companies in the study, as well as introducing the five-factor model (Fama & French, 2014), as well as introducing other risk factors, such as NI/CFO, suggested by Foye *et al.* (2013).

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APPENDICES

Appendix A.Companies on RTS index.

N	Code	Security name	Number of issued shares	Weight
1	GAZP	JSC „GAZPROM", Ordinary shares	23 673 512 900	15,00%
2	LKOH	OAO „LUKOIL", Ordinary shares	850 563 255	12,59%
3	SBER	Sberbank, Ordinary shares	21 586 948 000	10,51%
4	SBERP	Sberbank, Preferred shares	1 000 000 000	0,73%
5	MGNT	PJSC „Magnit", Ordinary shares	94 561 355	8,46%
6	SNGS	„Surgutneftegas" OJSC, Ordinary shares	35 725 994 705	3,66%
7	SNGSP	„Surgutneftegas" OJSC, Preferred shares	7 701 998 235	2,71%
8	GMKN	„OJSC „MMC „NORILSK NICKEL", Ordinary shares	158 245 476	5,88%
9	NVTK	JSC „NOVATEK", Ordinary shares	3 036 306 000	5,29%
10	ROSN	Rosneft, Ordinary shares	10 598 177 817	4,17%
11	MTSS	MTS OJSC, Ordinary shares	2 066 413 562	3,57%
12	VTBR	JSC VTB Bank, Ordinary shares	12 960 541 337 338	3,31%
13	TATN	JSC „TATNEFT", Ordinary shares	2 178 690 700	2,43%
14	TATNP	JSC „TATNEFT", Preferred shares	147 508 500	0,30%
15	TRNFP	JSC „Transneft", Preferred shares	1 554 875	2,60%
16	URKA	OJSC Uralkali, Ordinary shares	2 936 015 891	1,81%
17	POLY	Polymetal International plc, Ordinary shares	420 819 943	1,37%
18	YNDX	Yandex N.V., Ordinary shares	260 424 342	1,36%
19	MFON	OJSC „MegaFon", Ordinary shares	620 000 000	1,28%
20	RTKM	OJSC „Rostelecom", Ordinary shares	2 669 204 301	1,12%
21	RTKMP	OJSC „Rostelecom", Preferred shares	242 831 469	0,14%
22	ALRS	OJSC „ALROSA", Ordinary shares	7 364 965 630	1,13%
23	CHMF	OAO Severstal, Ordinary shares	837 718 660	1,12%

N	Code	Security name	Number of issued shares	Weight
24	HYDR	JSC „RusHydro", Ordinary shares	386 255 464 890	1,11%
25	MOEX	Moscow Exchange, Ordinary shares	2 278 636 493	0,98%
26	RUALR	Rusal, RDR	2 000 000 000	0,82%
27	NLMK	NLMK, Ordinary shares	5 993 227 240	0,71%
28	AFKS	Sistema JSFC, Ordinary shares	9 650 000 000	0,63%
29	PHOR	OJSC „PhosAgro", Ordinary shares	129 500 000	0,56%
30	PIKK	„PIK Group", Ordinary shares	660 497 344	0,53%
31	BANE	JSOC Bashneft, Ordinary shares	150 570 662	0,32%
32	BANEP	JSOC Bashneft, Preferred shares	29 788 012	0,22%
33	EONR	JSC „E.ON Russia", Ordinary shares	63 048 706 145	0,39%
34	MAGN	OJSC MMK, Ordinary shares	11 174 330 000	0,27%
35	LSRG	OJSC LSR Group, Ordinary shares	103 030 215	0,27%
36	DIXY	DIXY Group, Ordinary shares	124 750 000	0,25%
37	PHST	JSC „Pharmstandard", Ordinary shares	37 792 603	0,25%
38	GCHE	OJSC „Cherkizovo Group", Ordinary shares	43 963 773	0,24%
39	TRMK	TMK, Ordinary shares	937 586 094	0,24%
40	IRAO	JSC „Inter RAO", Ordinary shares	104 400 000 000*	0,24%
41	MVID	OJSC „Company „M. video", Ordinary shares	179 768 227	0,23%
42	AFLT	JSC „Aeroflot", Ordinary shares	1 110 616 299	0,21%
43	FEES	„FGC UES", JSC, Ordinary shares	1 274 665 323 063	0,20%
44	RSTI	JSC „ROSSETI", Ordinary shares	161 078 853 310	0,16%
45	AKRN	JSC Acron, Ordinary shares	40 534 000	0,13%
46	VSMO	VSMPO-AVISMA Corporation, Ordinary shares	11 529 538	0,11%
47	MSTT	OJSC „MOSTOTREST", Ordinary shares	282 215 500	0,10%
48	BSPB	„Bank „Saint-Petersburg" OJSC, Ordinary shares	439 554 000	0,09%
49	SVAV	SOLLERS OJSC, Ordinary shares	34 270 159	0,09%
50	NMTP	PJSC „NCSP", Ordinary shares	19 259 815 400	0,07%

Highlighted companies either financial or have no data available

Appendix B.Market Return Calculation.

Date	Last Price	RM	RF				
01.12.2008	631.89		Date	Last price	Rf/100	Rm-Rf	Rm-Rf*100
01.01.2009	535.04	−0.1532703	01.01.2009	12.575	0.12575	−0.27902	−27.9020348
01.02.2009	544.58	0.01783044	01.02.2009	12.693	0.12693	−0.1091	−10.9099557
01.03.2009	689.63	0.26635205	01.03.2009	12.796	0.12796	0.138392	13.83920511
01.04.2009	832.87	0.20770558	01.04.2009	10.677	0.10677	0.100936	10.09355813
01.05.2009	1087.59	0.30583404	01.05.2009	11.28	0.1128	0.193034	19.30340437
01.06.2009	987.02	−0.0924705	01.06.2009	11.297	0.11297	−0.20544	−20.5440508
01.07.2009	1017.47	0.03085044	01.07.2009	11.316	0.11316	−0.08231	−8.23095613

Date	Last Price	RM	Date	Last price	Rf/100	Rm-Rf	Rm-Rf*100
01.08.2009	1066.53	0.04821764	01.08.2009	11.515	0.11515	−0.06693	−6.69323621
01.09.2009	1254.52	0.17626321	01.09.2009	10.878	0.10878	0.067483	6.748320872
01.10.2009	1348.54	0.074945	01.10.2009	9.276	0.09276	−0.01782	−1.78150011
01.11.2009	1374.93	0.01956931	01.11.2009	9.087	0.09087	−0.0713	−7.1300688
01.12.2009	1444.61	0.05067894	01.12.2009	8.001	0.08001	−0.02933	−2.93310563
01.01.2010	1473.81	0.02021307	01.01.2010	7.751	0.07751	−0.0573	−5.72969321
01.02.2010	1410.85	−0.0427192	01.02.2010	7.723	0.07723	−0.11995	−11.9949211
01.03.2010	1572.48	0.11456214	01.03.2010	6.933	0.06933	0.045232	4.523214339
01.04.2010	1572.84	0.00022894	01.04.2010	7.113	0.07113	−0.0709	−7.09010623
01.05.2010	1384.59	−0.119688	01.05.2010	7.55	0.0755	−0.19519	−19.5187953
01.06.2010	1339.35	−0.0326739	01.06.2010	7.173	0.07173	−0.1044	−10.4403932
01.07.2010	1479.73	0.10481204	01.07.2010	7.077	0.07077	0.034042	3.404203569
01.08.2010	1421.21	−0.0395478	01.08.2010	7.308	0.07308	−0.11263	−11.2627755
01.09.2010	1507.66	0.06082845	01.09.2010	7.264	0.07264	−0.01181	−1.1811551
01.10.2010	1587.14	0.05271746	01.10.2010	7.591	0.07591	−0.02319	−2.31925438
01.11.2010	1597.35	0.00643295	01.11.2010	7.67	0.0767	−0.07027	−7.02670451
01.12.2010	1770.28	0.10826056	01.12.2010	7.441	0.07441	0.033851	3.385055655
01.01.2011	1870.31	0.05650519	01.01.2011	8.25	0.0825	−0.02599	−2.59948144
01.02.2011	1969.91	0.0532532	01.02.2011	8.763	0.08763	−0.03438	−3.4376796
01.03.2011	2044.2	0.03771238	01.03.2011	7.817	0.07817	−0.04046	−4.04576172
01.04.2011	2026.94	−0.0084434	01.04.2011	7.734	0.07734	−0.08578	−8.57834008
01.05.2011	1888.6	−0.0682507	01.05.2011	8.179	0.08179	−0.15004	−15.0040664
01.06.2011	1906.71	0.00958911	01.06.2011	8.127	0.08127	−0.07168	−7.16808864
01.07.2011	1965.02	0.03058147	01.07.2011	7.71	0.0771	−0.04652	−4.65185272
01.08.2011	1702.28	−0.1337086	01.08.2011	8.023	0.08023	−0.21394	−21.3938563
01.09.2011	1341.09	−0.2121801	01.09.2011	8.711	0.08711	−0.29929	−29.9290135
01.10.2011	1563.28	0.16567866	01.10.2011	8.712	0.08712	0.078559	7.855866437
01.11.2011	1540.81	−0.0143736	01.11.2011	8.306	0.08306	−0.09743	−9.74336247
01.12.2011	1381.87	−0.1031535	01.12.2011	8.5	0.085	−0.18815	−18.8153536
01.01.2012	1577.29	0.14141707	01.01.2012	8.29	0.0829	0.058517	5.851706528
01.02.2012	1734.99	0.09998161	01.02.2012	8.018	0.08018	0.019802	1.980161403
01.03.2012	1637.73	−0.056058	01.03.2012	7.825	0.07825	−0.13431	−13.430796
01.04.2012	1593.97	−0.0267199	01.04.2012	7.991	0.07991	−0.10663	−10.6629911
01.05.2012	1242.43	−0.2205437	01.05.2012	8.706	0.08706	−0.3076	−30.7603674
01.06.2012	1350.51	0.08699082	01.06.2012	8.46	0.0846	0.002391	0.239081638
01.07.2012	1377.35	0.01987397	01.07.2012	7.976	0.07976	−0.05989	−5.98860265
01.08.2012	1389.72	0.00898101	01.08.2012	7.86	0.0786	−0.06962	−6.96189857
01.09.2012	1475.7	0.06186858	01.09.2012	7.761	0.07761	−0.01574	−1.57414222
01.10.2012	1433.96	−0.0282849	01.10.2012	7.405	0.07405	−0.10233	−10.2334882

Date	Last Price	RM	Date	Last price	Rf/100	Rm-Rf	Rm-Rf*100
01.11.2012	1436.55	0.00180619	01.11.2012	6.93	0.0693	−0.06749	−6.74938129
01.12.2012	1526.98	0.06294943	01.12.2012	6.85	0.0685	−0.00555	−0.55505726
01.01.2013	1622.13	0.06231254	01.01.2013	6.6	0.066	−0.00369	−0.36874615
01.02.2013	1534.41	−0.054077	01.02.2013	6.69	0.0669	−0.12098	−12.0977047
01.03.2013	1460.04	−0.0484681	01.03.2013	6.91	0.0691	−0.11757	−11.7568141
01.04.2013	1407.21	−0.0361839	01.04.2013	6.53	0.0653	−0.10148	−10.148394
01.05.2013	1331.43	−0.0538512	01.05.2013	7.36	0.0736	−0.12745	−12.7451238
01.06.2013	1275.44	−0.0420525	01.06.2013	7.62	0.0762	−0.11825	−11.825253
01.07.2013	1313.38	0.0297466	01.07.2013	7.52	0.0752	−0.04545	−4.54534027
01.08.2013	1290.96	−0.0170705	01.08.2013	7.71	0.0771	−0.09417	−9.41704594
01.09.2013	1422.49	0.10188542	01.09.2013	7.31	0.0731	0.028785	2.87854186
01.10.2013	1480.42	0.04072436	01.10.2013	7.15	0.0715	−0.03078	−3.07756364
01.11.2013	1402.93	−0.0523433	01.11.2013	7.81	0.0781	−0.13044	−13.0443254
01.12.2013	1442.73	0.0283692	01.12.2013	7.71	0.0771	−0.04873	−4.87308013
01.01.2014	1301.02	−0.0982235	01.01.2014	8.39	0.0839	−0.18212	−18.2123507
01.02.2014	1267.27	−0.0259412	01.02.2014	8.33	0.0833	−0.10924	−10.9241185
01.03.2014	1226.1	−0.0324872	01.03.2014	8.93	0.0893	−0.12179	−12.1787157
01.04.2014	1155.7	−0.0574178	01.04.2014	9.47	0.0947	−0.15212	−15.2117829
01.05.2014	1295.75	0.12118197	01.05.2014	8.6	0.086	0.035182	3.518196764
01.06.2014	1366.08	0.05427745	01.06.2014	8.33	0.0833	−0.02902	−2.90225545
01.07.2014	1219.36	−0.1074022	01.07.2014	9.51	0.0951	−0.2025	−20.2502202
01.08.2014	1190.23	−0.0238896	01.08.2014	9.74	0.0974	−0.12129	−12.1289581
01.09.2014	1123.72	−0.05588	01.09.2014	9.4	0.094	−0.14988	−14.9879956
01.10.2014	1091.44	−0.028726	01.10.2014	9.99	0.0999	−0.12863	−12.8626017
01.11.2014	974.27	−0.1073536	01.11.2014	10.61	0.1061	−0.21345	−21.3453588
01.12.2014	790.71	−0.1884077	01.12.2014	14.09	0.1409	−0.32931	−32.9307731

Appendix C.Portfolio and Factor Returns.

Excess return		Risk free	S/L return	S/M return	S/H return	B/L return	B/M return	B/H return
2009	30.01.2009	12.575	−19.72821264	−36.33608022	−39.63294549	−31.77277103	−26.64923913	−25.05577618
	27.02.2009	12.693	−18.39041193	4.579412408	0.349685687	4.95747341	2.544722864	1.185818496
	31.03.2009	12.796	1.315738079	12.86562497	16.73473149	5.717032891	5.16589185	23.43613258
	30.04.2009	10.677	15.08008411	63.53633937	47.01308271	15.13763507	14.50655863	16.13842889
	29.05.2009	11.28	4.612088535	23.78438023	8.332628757	20.04380119	27.10423529	22.78314632
	30.06.2009	11.297	−17.36588399	−10.43592417	−16.21419471	−23.44142634	−20.83337368	−19.23381567
	31.07.2009	11.316	−13.36663461	−3.857581253	0.432711405	−10.09245713	5.806212528	−4.363674885
	31.08.2009	11.515	−15.22753552	−4.788282973	−3.635388716	−7.247312892	−9.091573987	−6.309312234
	30.09.2009	10.878	1.773348176	17.53228207	37.24081571	2.305959868	1.601230332	2.354461073

Excess return		Risk free	S/L return	S/M return	S/H return	B/L return	B/M return	B/H return
	30.10.2009	9.276	−0.035442071	−1.320629397	−5.392566218	−7.9492864	−4.755519262	−1.483822317
	30.11.2009	9.087	−4.323683104	−7.353102944	−1.743180162	−4.924419497	−2.130241278	−1.873876611
	31.12.2009	8.001	−6.750649848	7.141512134	−8.31324979	−10.35700775	−4.159408843	−5.193591357
2010	29.01.2010	7.75	−6.582647483	4.173696245	4.712763607	−2.645402063	1.829387862	−5.456748433
	27.02.2010	7.72	−8.379469746	2.43861495	2.065557229	−10.97655231	−8.883203277	−10.46151893
	31.03.2010	6.93	14.10495414	5.95439843	3.906278731	8.057580168	2.551152887	7.947338527
	30.04.2010	7.11	−15.86784496	−3.730333392	−6.053989687	−6.459929307	−2.379862855	−3.675050912
	31.05.2010	7.55	−24.6954747	−22.15952697	−22.30114889	−16.77378892	−24.307627	−16.08173204
	30.06.2010	7.17	−5.204209608	−12.84440984	−7.200113444	−12.53392766	−18.55303678	−11.35690502
	30.07.2010	7.08	5.54298619	0.206181764	0.357891874	4.84091959	5.685528362	6.610198107
	31.08.2010	7.31	−8.730019194	−8.755830532	−8.904793105	−11.92507029	−8.480712177	−6.808787908
	30.09.2010	7.26	1.734637958	−3.749141356	−3.814544943	−1.231758752	2.129519628	2.255290864
	29.10.2010	7.59	−2.095625172	−4.169306616	6.120528092	−4.561228091	−6.7800155	−4.655333547
	30.11.2010	7.67	−8.406649629	−4.928067145	−5.785114982	−9.249897876	−5.662728783	−3.383719248
	30.12.2010	7.44	0.253368382	−1.427168951	1.8376463	−1.776909391	5.31199093	14.14031085
2011	31.01.2011	8.25	−1.115675424	−1.359599207	−4.683049847	−2.378681046	−1.053944367	−7.37639929
	28.02.2011	8.76	−7.985943041	−6.921655063	−4.996170655	−4.763556382	−0.090813809	−2.815057466
	31.03.2011	7.82	−6.112985228	−9.374001829	−9.744698911	−7.62619745	−5.487235846	−2.27834988
	29.04.2011	7.73	−14.20409809	−9.568947775	−11.62311372	−11.27237176	−10.94161925	−7.269850951
	31.05.2011	8.18	−16.52602428	−11.93463922	−8.421294492	−15.21604092	−13.66392583	−8.120155438
	30.06.2011	8.13	−7.698123796	−7.143747116	−9.885751964	−3.806236668	−1.426014409	−8.752232838
	29.07.2011	7.71	−5.662759697	−4.384599961	−1.515304565	−4.510638582	−4.046844966	0.210661655
	31.08.2011	8.02	−25.29140002	−30.91359815	−20.08526508	−23.67965899	−22.21305997	−18.35276883
	30.09.2011	8.71	−35.91106769	−29.81133409	−19.1518306	−26.81526396	−36.02876397	−29.70281077
	31.10.2011	8.71	18.41952587	12.83114032	−3.541665205	8.636976255	15.41311715	6.80886365
	30.11.2011	8.31	0.799248896	−11.53515259	−8.650157015	−5.54308493	−7.866111869	−11.97966033
	30.12.2011	8.50	−22.3636752	−23.76036802	−21.34217125	−21.35030951	−18.82498953	−20.49725124
2012	31.01.2012	8.29	14.44928966	6.566822226	10.92971587	6.701004898	7.14429532	6.989660374
	29.02.2012	8.02	−0.969300785	−0.874474818	5.644644803	2.222767519	−2.571764648	1.155024408
	30.03.2012	7.83	−5.112824201	−7.903872667	−8.141262976	−15.76974014	−13.3690868	−10.62339149
	28.04.2012	7.99	−17.03807523	−8.574021187	−9.256441996	−14.08960302	−10.13641025	−8.157069678
	31.05.2012	8.71	−41.38997155	−29.60483607	−29.86443386	−31.01371812	−28.37141461	−25.71177302
	29.06.2012	8.46	4.969167269	−5.756621741	−3.537305053	1.194595226	−0.219215876	4.932396839
	31.07.2012	7.98	−4.308429444	0.060002265	−1.107207357	−6.480018911	−6.791346127	−2.98697694
	31.08.2012	7.86	−5.651843646	−8.000905746	−2.825683965	−9.079465547	−5.949423112	−10.1449125
	28.09.2012	7.76	12.31932669	−4.531940252	−0.200344121	−0.171929624	3.071849773	−4.612552012
	31.10.2012	7.41	−13.98676427	−10.09816867	−5.789588874	−12.07488584	−8.892853482	−7.964648364
	30.11.2012	6.93	−0.46376053	−4.219760012	−6.777685166	−6.468551005	−8.390720782	−6.84331812
	28.12.2012	6.85	−5.041150064	−1.285021858	5.46571189	−4.063452117	0.847178882	2.232372445

Excess return		Risk free	S/L return	S/M return	S/H return	B/L return	B/M return	B/H return
2013	31.01.2013	6.60	−0.552804291	5.635668586	−1.143369839	1.48212265	−3.332505902	−1.068430901
	28.02.2013	6.69	−17.96311588	−5.968661244	−9.116912806	−13.32328245	−13.77592715	−6.681903161
	29.03.2013	6.91	−20.12755309	−14.04139633	−12.38777747	−12.2444703	−14.81018082	−9.073992559
	30.04.2013	6.53	−25.77657545	−10.25160437	−8.863511747	−10.88489005	−9.250567231	−5.759191262
	31.05.2013	7.36	−11.02992481	−11.85679154	−2.850630309	−14.31556639	−12.540811	−8.428459749
	28.06.2013	7.62	−12.19203794	−7.570582757	−11.06004754	−9.348807742	−14.70718804	−4.226227649
	31.07.2013	7.52	−4.505961945	−8.437611937	−2.516414376	0.696308979	2.934592015	−4.447860065
	30.08.2013	7.71	−12.13615766	−10.80023978	−14.9455255	−8.389804046	−3.690474513	−10.09646232
	30.09.2013	7.31	−5.984026902	−3.383796048	−1.470341863	1.281752312	−3.027100409	4.215271861
	31.10.2013	7.15	−12.08145712	−2.783206249	−3.575804298	−3.41633146	−2.356212794	−2.111143017
	29.11.2013	7.81	−21.66433942	−13.76525126	−1.708370891	−13.19557616	−13.98985701	−11.41276352
	30.12.2013	7.71	3.188647883	−1.125006942	−5.070358172	−5.241958867	−4.519890774	−3.921838374
2014	31.01.2014	8.39	−15.98225971	−17.68566987	−29.38937671	−13.35744352	−17.94721508	−20.96411795
	28.02.2014	8.33	−19.50465795	−11.69134737	−5.255090106	−11.46010086	−10.467399	−5.925412063
	31.03.2014	8.93	−20.72174722	−13.21953684	−14.46743817	−8.912013286	−12.08504252	−14.65915682
	30.04.2014	9.47	−20.13617147	−5.335384344	−5.97424	−13.45053776	−14.30159712	−14.03541342
	30.05.2014	8.60	7.097977213	1.841096917	13.63315336	10.54860177	−2.867843711	6.784463341
	30.06.2014	8.33	−4.515921925	0.012443634	−6.663242964	−4.205746189	−0.611567816	−0.825278428
	31.07.2014	9.51	−20.04237094	−17.73863001	−16.89032658	−20.11551796	−16.50444922	−11.23486283
	29.08.2014	9.74	−10.66672734	−12.42346596	−9.616919633	−7.652314776	−8.144987191	−11.77036551
	30.09.2014	9.40	−17.80486826	−11.74676508	−8.352807762	−12.84270593	−12.58402409	−10.30214226
	31.10.2014	9.99	−17.41752488	−20.43896404	−7.988448766	−17.41813329	−11.95157592	−8.415636781
	28.11.2014	10.61	−22.3985549	−22.85012079	−15.72240212	−29.66080774	−20.31521596	−20.11267458
	30.12.2014	14.09	−45.28022728	−29.08015218	−38.16437407	−32.97312081	−31.22990192	−32.65832548

Appendix D.Factor Correlation

	SMB	HML
SMB	1	
HML	0.217556	1

Appendix E.Initial Regression Results

Initial Regression Results						
	Fama-French				CAPM	
Factors	α_{it}	β_{im}	β_{is}	β_{ih}	α	β_{im}
S/L	1.1303***	1.0030***	0.7128***	− 0.8329***	−0.833	1.082***
S/M	1.3849***	1.0566***	0.9213***	0.2685***	2.819**	1.144***
S/H	0.1579	0.9752***	0.9293***	0.6837***	2.824**	1.058***
B/L	0.3083*	0.9942***	−0.0143	− 0.1600**	−0.174	0.995***

B/M	1.0841*	1.0186***	– 0.1915*	–0.0442	0.82	1.000***
B/H	1.2807*	1.0220***	– 0.2308***	0.3234***	2.075***	0.996***

*	Significant level of 10%
**	Significant level of 5%
***	Significant level of 1%

White's test		
Portfolio	**Fama-French**	**CAPM**
S/L	0.935433526	**4.23848778**
S/M	**10.6971544**	0.01362068
S/H	0.109362511	**6.51996791**
B/L	2.718457331	0.07874379
B/M	0.240396121	2.63387205
B/H	1.909519883	1.42075774
Critical chi-square value	**2.71**	

Breusch-Godfrey LM test		
	Fama-French	**CAPM**
S/L	0.557561036	0.40213137
S/M	1.784380886	0.36993566
S/H	2.850135314	**6.667736**
B/L	3.202873923	1.52200262
B/M	2.213281447	5.08838262
B/H	3.154990149	1.90950933
Chi-square	9.49 (5%)	5.99 (5%)
	13.28 (1%)	9.21 (1%)

Appendix F.Adjusted Regression Results

Adjusted Regression Results						
	Fama-French				**CAPM**	
Factors	α_{it}	β_{im}	β_{is}	β_{ih}	α	β_{im}
S/L	1.1303***	1.0030***	0.7128***	– 0.8329***	– 2.039***	3.334***
S/M	–0.1960	0.8861***	1.1999***	0.2139***	2.819**	1.144***
S/H	0.1579	0.9752***	0.9293***	0.6837***	4.554***	1.117***
B/L	0.3083*	0.9942***	–0.0143	– 0.1600**	–0.174	0.995***
B/M	1.0841*	1.0186***	– 0.1915*	–0.0442	0.82	1.000***
B/H	1.2807*	1.0220***	– 0.2308***	0.3234***	2.075***	0.996***

*	Significant level of 10%
**	Significant level of 5%
***	Significant level of 1%

White's test		
Portfolio	**Fama-French**	**CAPM**
S/L	0.935433526	7.74837526
S/M*	1.169987113	0.01362068
S/H	0.109362511	6.51996791
B/L	2.70145733	0.07874379
B/M	0.240396121	2.63387205
B/H	1.909519883	1.42075774
Critical chi-square value	**2.71**	

Breusch-Godfrey LM test		
	Fama-French	**CAPM**
S/L	0.557561036	0.40213137
S/M	1.784380886	0.36993566
S/H	2.850135314	0.60786256
B/L	3.202873923	1.52200262
B/M	2.213281447	5.08838262
B/H	3.154990149	1.90950933
Chi-square	9.49 (5%)	5.99 (5%)
	13.28 (1%)	9.21 (1%)

Appendix G.Adjusted Regression Statistics

	R squared		F-Statistics		P-value	
Factors	**Fama-French**	**CAPM**	**Fama-French**	**CAPM**	**Fama-French**	**CAPM**
S/L	94%	75%	346.611	208.402	0.00000	0.00000
S/M	90%	43%	113.510	148.978	0.00000	0.00000
S/H	93%	72%	311.552	129.542	0.00000	0.00000
B/L	89%	88%	182.433	519.778	0.00000	0.00000
B/M	86%	85%	137.601	391.692	0.00000	0.00000
B/H	93%	90%	310.675	600.156	0.00000	0.00000
Average	91%	75%				