St. Petersburg State University
Graduate School of Management

Master in Corporate Finance

# NONMARKETABLE ASSETS AND CAPITAL MARKET EQUILIBRIUM UNDER UNCERTAINTY

Master's Thesis by the 2nd year student
Concentration – Corporate Finance
Lasha Bokuchava

Research advisor:
Alexander V. Bukhvalov, Professor

St. Petersburg

2016

ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

Я, Бокучава Лаша Зурабович, студент второго курса магистратуры направления «Менеджмент», заявляю, что в моей магистерской диссертации на тему «Неторгуемые Активы и Равновесие на Рынках Капитала в Условиях Неопределенности», представленной в службу обеспечения программ магистратуры для последующей передачи в государственную аттестационную комиссию для публичной защиты, не содержится элементов плагиата.

Все прямые заимствования из печатных и электронных источников, а также из защищенных ранее выпускных квалификационных работ, кандидатских и докторских диссертаций имеют соответствующие ссылки.

Мне известно содержание п. 9.7.1 Правил обучения по основным образовательным программам высшего и среднего профессионального образования в СПбГУ о том, что «ВКР выполняется индивидуально каждым студентом под руководством назначенного ему научного руководителя», и п. 51 Устава федерального государственного бюджетного образовательного учреждения высшего образования «Санкт-Петербургский государственный университет» о том, что «студент подлежит отчислению из Санкт-Петербургского университета за представление курсовой или выпускной квалификационной работы, выполненной другим лицом (лицами)».

_______________________________________ (Подпись студента)

_______________ 24.05.2015 _______________ (Дата)

STATEMENT ABOUT THE INDEPENDENT CHARACTER OF THE MASTER THESIS

I, Lasha Bokuchava, second year master student, program «Management», state that my master thesis on the topic «Nonmarketable Assets and Capital Market Equilibrium under Uncertainty», which is presented to the Master Office to be submitted to the Official Defense Committee for the public defense, does not contain any elements of plagiarism.

All direct borrowings from printed and electronic sources, as well as from master theses, PhD and doctorate theses which were defended earlier, have appropriate references.

I am aware that according to paragraph 9.7.1. of Guidelines for instruction in major curriculum programs of higher and secondary professional education at St.Petersburg University «A master thesis must be completed by each of the degree candidates individually under the supervision of his or her advisor», and according to paragraph 51 of Charter of the Federal State Institution of Higher Education Saint-Petersburg State University «a student can be expelled from St.Petersburg University for submitting of the course or graduation qualification work developed by other person (persons)».

_______________________________________ (Student’s signature)

_______________ 24.05.2015 _______________ (Date)

**АННОТАЦИЯ**

| | |
|---|---|
| Автор | Бокучава Лаша Зурабович |
| Название магистерской диссертации | Неторгуемые Активы и Равновесие на Рынках Капитала в Условиях Неопределенности |
| Факультет | Высшая Школа Менеджмента |
| Направление подготовки | Корпоративные Финансы |
| Год | 2016 |
| Научный руководитель | Бухвалов Александр Васильевич |
| Описание цели, задач и основных результатов | В данной работе автор обращает особое внимание на модель, разработанную Дэвидом Майерсом (1972), который расширил модель CAPM путем добавления в нее эффекта от неторгуемого актива. Майерсом была исследована роль доходности человеческого капитала как прокси для неторгуемого актива. Расширенная модель Майерса предполагает, что, поскольку человеческий капитал любого индивидуального инвестора является уникальным, ковариация между рыночным портфелем и выплатами человеческому капиталу будет иметь влияние на оптимальный вес рыночного портфеля, таким образом, ковариация объясняет, почему инвесторы держат различные портфели в реальности.<br>Основной целью этого исследования является проверка значимости модели CAPM с неторгуемыми активами на российском рынке.<br>Следующие задачи выполняются для реализации конечной цели исследования:<br>1. Анализ теоретических и эмпирических работ, касающихся традиционной CAPM;<br>2. Анализ теоретических и эмпирических работ, касающихся CAPM с неторгуемыми активами<br>3. Разработка методики расчета разницы между традиционной мерой риска по CAPM и мерой риска Майерса<br>4. Сбор данных о 50 наиболее ликвидных акциях крупнейших российских компаний. Компании дополнительно поделены на 10 различных сегментов экономики, чтобы точнее оценить влияние доходности на человеческий капитал по различным классам активов;<br>5. Регрессионный анализ для оценки |

| | |
|---|---|
| | меры риска для соответствующих классов активов;<br>6. Расчет различия между показателями риска Майерса и традиционной CAPM, чтобы проверить, приводят ли эти различия к значительным отклонениям в окончательных оценках доходности рискованных активов в России;<br>7. Интерпретация результатов и ограничения подхода.<br>В отличие от традиционной модели CAPM, расширенная модель предполагает, что не все инвесторы держать одинаковый портфель рыночных активов. Это означает, что каждый инвестор владеет портфелем активов, который решает его личную (и, возможно, уникальную) портфельную проблему.<br>Эмпирический анализ CAPM с неторгуемыми активами показал значительную разницу оценок моделей для сектора Инноваций. Бета предсказанная расширенной моделью на 9.2% выше, чем традиционная бета. К сожалению, исследованию не удалось доказать обоснованность модели для других секторов компаний и для рынка в целом, что может быть связано с ограничениями, указанными в работе. Эти ограничения включают в себя: 1) споры о способе определения человеческого капитала, 2) противоречие использования человеческого капитала в качестве прокси, и 3) несовершенство данных на российском фондовом рынке. |
| Ключевые слова | Неторгуемые активы, Рынки капитала, Инвестор, Доходность, Модель оценки долгосрочных активов, CAPM, ММВБ |

## ABSTRACT

| | |
|---|---|
| Master Student's Name | Lasha Bokuchava |
| Master Thesis Title | Nonmarketable Assets and Capital Market Equilibrium under Uncertainty |
| Faculty | Graduate School of Management |
| Main field of study | Corporate Finance |
| Year | 2016 |
| Academic Advisor's Name | Alexander V. Bukhvalov |
| Description of the goal, tasks and main results | In this paper, the author pays special attention to the model developed by Mayers (1972), who challenged the assumption of marketability of all assets by introducing the effect of |

| | |
|---|---|
| | nonmarketable assets. Mayers examined the role of returns to human capital as a proxy for nonmarketable asset. Mayers' extended model suggests that since any individual investor's human capital is unique, the covariance between the market portfolio and payoffs to human capital will have an impact on the optimal weight of the market portfolio, therefore, the covariance explains why investors hold different portfolios in reality.<br>This research aims to understand whether the CAPM with nonmarketable assets has meaningful implications in the Russian market.<br>The following objectives are met to realize the ultimate goal of the paper:<br>1. Theoretical and empirical background of the traditional Capital Asset Pricing Model are covered;<br>2. Theoretical and empirical background of the CAPM model with nonmarketable assets are covered;<br>3. Methodologies for the calculation of differences between the Mayers and SLM risk measures are derived;<br>4. The data on 50 most liquid stocks of Russia's largest companies is obtained. The companies are further segmented into 10 different sectors of economy to precisely evaluate the effect of returns to human capital on different classes of assets;<br>5. Regressions are run to estimate risk measures for respective classes of assets;<br>6. Differences between the Mayers and SLM risk measures are calculated to check whether this differences lead to significant deviations in final estimations of the required returns on risky assets in Russia;<br>7. Interpretation of results and limitations of the approach are elaborated.<br>Contrary to the SLM model, the expanded model implies that not all maximizing investors hold the identical (except for scale) portfolio of marketable assets. It implies that each investor holds a portfolio of marketable assets that solves his personal (and possibly unique) portfolio problem and, therefore, allows investors to maintain unique portfolios.<br>Empirical analysis of the CAPM with nonmarketable assets has shown significant difference of the estimates of the models for Innovations sectors. The beta predicted by extended model is 9.2% higher than the SLM |

| | |
|---|---|
| | beta. Unfortunately, the research has failed to prove the validity of the model for other sectors of companies and for the market in general, which may be attributable to the limitations stated in the paper. These limitations include: 1) the quarrels about the way to define human capital, 2) the controversy of using human capital as a proxy, and 3) the imperfection of data on Russian stock market. |
| Keywords | Nonmarketable assets, Capital markets, Investor, Return, Capital asset pricing model, CAPM, MICEX |

# Content

# Introduction

For the fund managers the decision to invest or not is usually based on such factors as expected return on the security and the risk of the unfavorable deviations. Currently, the Capital Asset Pricing Model is the most popular model among investors to calculate the returns on securities. According to CAPM, the total risk of a security can be broken down into systematic (undiversifiable) and asset-specific (diversifiable) risks. The model suggests that investors require premium only for systematic risk, since specific risk can be completely eliminated by diversification, and the systematic risk measure, $\beta$, depends on the covariation of asset returns with market returns. As any other financial theory, CAPM implies a number of assumptions:

- Investors are risk-averse maximizers of expected returns;
- All investors can give loans and borrow an unlimited amount of money at a certain risk-free interest rate;
- All investors have similar expectations;
- All assets are perfectly divisible and liquid;
- There are no transaction costs or taxes;
- All investors take price as an exogenously given value;
- The number of all financial assets is fixed and determined in advance;
- All investors have the same fixed holding period;
- All information is available to all investors at zero costs.

These assumptions, which are rather strict and unrealistic, have caused many doubts around the validity of the model. Vast amount of research has been done to prove insufficiency of CAPM – various authors claimed that actual returns differ significantly from those predicted by the Sharpe-Lintner-Mossin CAPM, and tried to improve the model by extending it through inclusion of new factors.

In this paper, the author pays special attention to the model developed by Mayers (1972), who challenged the assumption of marketability of all assets by introducing the effect of nonmarketable assets. Mayers examined the role of returns to human capital as a proxy for nonmarketable asset. Mayers' extended model suggests that since any individual investor's human capital is unique, the covariance between the market portfolio and payoffs to human capital will have an impact on the optimal weight of the market portfolio, therefore, the covariance explains why investors hold different portfolios in reality. In his work Mayers derived and suggested extended formula for calculating the measure of risk:

$$\beta_j^* = \frac{V_M cov(R_j, R_M) + cov(R_j, D_H)}{V_M \sigma_M^2 + cov(R_M, D_H)}$$

Where

| | |
|---|---|
| $R_j$ | is the return on asset j, |
| $R_M$ | is the return on market portfolio, |
| $D_H$ | is the total payoff to human capital in the economy, |
| $V_M$ | is the total value of marketable assets in the economy, |
| $\sigma_M^2$ | is the variation of the returns of market portfolio. |

There were several research papers in which Mayers model was considered and empirically tested for validity. The most famous was the paper of Fama and Schwert (1977), who analyzed the effect of human capital on the returns of the US assets over the period of 1950s – 1970s. Jagannathan and Wang (1996) introduced the model with conditional returns, and observed that human capital forms a substantial part of the aggregate capital stock in the US. The key findings of these papers will be further presented in the coming chapters.

As stated earlier, Russian market is currently one of the riskiest. Now, it is extremely important for investors to be as precise as possible in estimations of risk and return on their portfolio or potential investments, and CAPM with nonmarketable assets can be a possible solution at this point.

To the best of my knowledge, there are no major researches in this field for the Russian market. Therefore, the topic is extremely urgent and relevant. Even though it has been more than 40 years since Mayers first published his work on nonmarketable assets and capital market equilibrium, the author of this paper believes that the theory developed by Mayers is meaningful from economic point of view and can contribute to explaining the relationship between risk and return in the contemporary Russian market.

This research aims to understand whether the CAPM with nonmarketable assets has meaningful implications[1] in the Russian market.

The following objectives are met to realize the ultimate goal of the paper:

1. Theoretical and empirical background of the traditional Capital Asset Pricing Model are covered;

[1] By meaningful implications the author means that the model will yield the results significantly different from those produced by SLM CAPM.

2. Theoretical and empirical background of the CAPM model with nonmarketable assets are covered;
3. Methodologies for the calculation of differences between the Mayers and SLM risk measures are derived;
4. The data on 50 most liquid stocks of Russia's largest companies is obtained. The companies are further segmented into 10 different sectors of economy to precisely evaluate the effect of returns to human capital on different classes of assets;
5. Regressions are run to estimate risk measures for respective classes of assets;
6. Differences between the Mayers and SLM risk measures are calculated to check whether this differences lead to significant deviations in final estimations of the required returns on risky assets in Russia;
7. Interpretation of results and limitations of the approach are elaborated.

The rest of the paper is organized as follows. In *Chapter 1*, the author covers main theoretical background of the problem and provides the relevant methodology for the calculation of the risk measure. Chapter 2 describes the data and states the results of the empirical research. After that, the author presents the interpretation of the obtained results and explains some limitations.

# Chapter 1. CAPM with nonmarketable assets

## 1.1 Overview of the traditional CAPM model

### *Overview of the model and its key assumptions*

The debates about which factors best explain the return on securities are still in place. One of the first and still the most popular works in this area is the Capital Asset Pricing Model, or CAPM. It was developed in early 1960's by Jack Trainor (1962), William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966) independently.

In his work, W. Sharpe[2] (Sharpe 1964) developed a theory according to which the return on any marketable asset depends on three factors. The first is the risk-free rate of return – a significant factor in determining the profitability of the portfolio, which represents the investor's price of time. The author believed that any investor can get a risk-free rate of return on their investments, regardless of the circumstances, so if money is not invested, they create opportunity costs. The second factor is the excess return of the market portfolio over the risk-free rate – it represents a reference point (benchmark) for the investor. This means that on markets with a higher excess return over the risk-free rate, the investor is entitled to a higher portfolio returns. Finally, the third factor – the risk (sensitivity of asset returns to fluctuations in market yields) also determines the return on a security, as investors require higher returns from riskier assets (price of risk), otherwise, all other things being equal, it would be preferable to invest in less risky assets.

As any other financial theory, CAPM also implies a number of assumptions, including the assumption of market efficiency. They are as follows:

- The main goal of every investor is to maximize the returns on their assets at the end of the planning period by estimating the expected returns and standard deviation of alternative investment portfolios;
- Investors are risk-averse, meaning they require additional returns for additional risk;
- All investors can give loans and borrow an unlimited amount of money at a certain risk-free interest rate;
- There are no restrictions on the short selling of any assets[3];

[2] William F. Sharpe, 'Capital Asset Prices – A Theory of Market Equilibrium under Conditions of Risk'. The Journal of Finance, Vol. XIX (Issue 3) 1964, pp. 425–442.
[3] The term 'short selling' means that the investor sells securities, which he or she does not possess, expecting to buy them back at a lower price. If the price of a short-sold security rises, the investor is in loss, and if the price goes down the investor makes profit.

- All investors have the same expectations about future returns, variation and covariance of returns of all assets. This implies that investors are in equal conditions regarding the prediction of parameters;
- All assets are perfectly divisible and liquid (i.e., they can always be traded on the market at the current price);
- There are no transaction costs;
- There are no taxes;
- All investors take price as an exogenously given value (i.e., all investors assume that their activity of buying and selling securities does not affect the level of prices).
- The number of all financial assets is fixed and determined in advance;
- All investors have the same fixed holding period;
- All information is available to all investors at zero costs.

The subsequent development of theoretical CAPM made many of these assumptions less stringent and generally led to results that are consistent with the basic theory. Nevertheless, even the more recent studies contain assumptions, which are very strict and unrealistic. Therefore, the validity of this model can be confirmed only by means of empirical research. Further in this chapter the author provides an overview of the studies on empirical validity of CAPM, but first it is necessary to give a description of the model.

Despite its high value, CAPM is quite easy to comprehend. It carries out the connection between the return on the asset and the market on which it is listed. Thus, it assumes that the returns on assets that belong to the same market are interconnected and have a common component. It is also important to note that the CAPM model is an equilibrium model. It can mathematically be presented by the following formula:

$$E[\tilde{R}_j] = R_f + \beta_j \times (E[\tilde{R}_M] - R_f) \quad (1)$$

$$\beta_j = \frac{cov(\tilde{R}_j;\tilde{R}_M)}{\sigma^2(\tilde{R}_M)} \quad (2)$$

Where

$E[\tilde{R}_j]$ is the expected return on a long-term asset,

$R_f$ is the risk-free rate,

$\beta_j$ is the risk coefficient,

$E[\tilde{R}_M]$ is the expected return on the market portfolio.

Formula (1), also called the Security Market Line or SML, allows for the calculation of return on a risky asset (certainty equivalent).

The main conclusions one can draw from SML are: 1) the interpretation of beta coefficient, and 2) the breakdown of the total risk of an asset by systematic (undiversifiable) and asset-specific (diversifiable) risks:

1. $\beta_j$ measures the sensitivity of asset *j* returns to the market portfolio returns;
2. Total risk can be expressed by the formula: $\sigma^2(R_j) = \beta_j^2 \sigma^2(R_M) + \sigma_{j,spec}^2$.

Moreover, SML assumes that the estimation in (1) is made in terms of a fully diversified portfolio, which completely eliminates the specific risk of every single security due to covariation effects. This is reasonable because a rational investor sees no point in paying for the risk that can be eliminated by diversification, i.e. investors only pay for the risk, which is not possible to get rid of.

***Effect of inflation***

The risk-free rate of return, measured by the interest rate on treasury bonds, is the nominal rate is composed of two elements: 1) the real, non-inflated return, $R_f^r$, and 2) the inflation premium, *IP*, equal to the expected rate of inflation[4].

Thus, $R_f = R_f^r + IP$, meaning if inflation takes place, then a premium should be added to the real risk-free yield to compensate investors for the loss of purchasing power, which occurs as a result of inflation. Note that in CAPM, the increase in $R_f$ by a certain amount also leads to an increase in the yield of all risky assets by the same amount, due to the fact that the inflation premium is included in the returns of both risk-free and risky assets.

## 1.2 Empirical tests of SLM CAPM

As noted earlier, the CAPM model was developed based on a series of partly unrealistic assumptions. If all these conditions were fair, the CAPM would represent an ideal, true model. But due to the conditional nature of key prerequisites of the model, the SML equation (1) is not quite adequate to the real attitude of investors to the process of defining required returns on

[4] Inflation premium for each asset is equal to the average expected inflation rate over the life of the asset. Thus, it is assumed that all securities on the SML graph have the same lifetime, and the expected rate of inflation is constant. It should also be noted that the risk-free rate in CAPM can be expressed as either a long-term (e.g., in the U.S. – Treasury bonds) or a short-term (Treasury bills) interest rate. In recent years, there has been a tendency to use the interest rate of long-term Treasury bonds, as they are more closely correlated with stock returns.

individual stocks in the market. Thus, assuming that a large number of investors has stock portfolios undiversified, in this situation, first, beta cannot be regarded as adequate risk criterion; second, it is unreasonable to use SML as a tool to explain the logic of calculation of the required return. In addition, the relationship described by CAPM is obviously distorted by the presence of tax payments and expenses on operations with securities.

These arguments indicate that the CAPM is likely to not fully reflect the actual situation; SML, in turn, does not give an accurate estimation of the required return. Therefore, empirical testing of CAPM, which could confirm its validity and suitability for practical application, is necessary. The literature on empirical testing of CAPM is very extensive; therefore, the author only gives a brief overview of some key works in this area.

***Stationarity of β coefficients***

According to CAPM, beta coefficient (used to measure the market risk of the stock) should reflect investors estimate of the future sensitivity of the share prices in relation to changes in the market situation. Obviously, it is not known in advance how exactly the future stock performance will be associated with the average of their values, and how the average investor will assess the relative future variability of the price. There are only statistical data on the dynamics of shares that can be used for the construction of the characteristic line and for the calculation of actual beta. If the value of the beta coefficient has not changed for some time, it may seem that there are grounds for investors to use the current trend for the evaluation and calculation of future sensitivity of the stocks to market. But how valid such assumption is?

Robert Levy (1971)[5], Marshall Bloom (1975)[6] and other researchers considered the problem of stationarity of beta coefficients in their works. Levi, in particular, has come to the following conclusions, based on the results of calculations and the analysis of the dynamics of betas for a number of individual stocks and securities portfolios:

i. beta of any particular security is not stable over time and therefore cannot serve as an accurate assessment of future risk;
ii. beta of a portfolio, consisting of 10 or more randomly selected stocks, is stationary and can therefore be considered a good estimate of future portfolio risk. This

[5] Levy R. A. ‘On the Short-Term Stationarity of Beta Coefficients’. Financial Analysts Journal, issue November 1971, pp. 55-62.
[6] Blume M.E. ‘Betas and Their Regression Tendencies’. The Journal of Finance, issue June 1975, pp. 785-796.

conclusion is quite reasonable, because the errors in the estimates of beta values for randomly selected stocks mutually cancel each other in the portfolio.

Works of Blum and other researchers confirmed the results of Levi.

These tests for the stationarity of beta lead to the following conclusion – CAPM is a concept more suitable for explaining the structure of investment portfolios rather than for the assessment of individual financial assets.

***CAPM tests based on the construction of the SML line***

According to the Capital asset pricing model concept, there is a linear relationship between the required return on the security and its beta coefficient. Moreover, SML line crosses the y-axis at the point $R_f$, and the required rate of return on a security (or a portfolio) with beta of 1.0 is the average market yield.

Many researchers have tried to verify the viability of this model on the actual material. Typically, such an analysis uses historical data on monthly stock returns, and the YTM of long-term treasury bonds as a risk-free rate. Additionally, the majority of studies is devoted to the analysis of portfolio investment, rather than individual securities, due to the instability of beta coefficients.

Before presenting the key findings of the aforementioned studies, it is necessary to stress once again that, although the CAPM is an ex ante model (estimation model), it can only be checked for adequacy based on the factual material, i.e. historical data, and there is no reason to believe that the historical data on the returns will necessarily coincide with the expected yields, with which the model is dealing. In addition, the historical beta can both reflect and not reflect the current and expected risk. This quite understandable lack of a future state of the market data makes it incredibly difficult to test for the validity of CAPM.

The key findings are as follows:

i. The results generally confirm the hypothesis of a close direct relationship between the actual returns and systematic risk. However, the slope of the SML line that reflects this dependence is usually less steep than the slope predicted by the CAPM.

ii. The assumption of linearity of relationship between risk and return is quite reasonable. Empirical studies have not produced any significant evidence to abandon this premise.

iii. Studies, which aimed to establish the relative importance of the systematic (undiversifiable) and specific (diversifiable) risk, did not yield any definite results. CAPM theory assumes that diversifiable risk is not relevant; yet it turned out that both types of risk are positively correlated with the returns on the securities, i.e. it turns out that the higher rate of return is expected to compensate for a diversifiable risk as well as market risk. However, it is possible that this relationship is only partly true, meaning that it may reflect the statistical relationship, but not the true nature of the capital markets.

iv. Richard Roll (1977)[7] questioned the possibility of precise conceptual test of CAPM. Roll showed that a linear relationship, which the previous researchers observed, was the result of mathematical characteristics of the tested model, so the discovery of linear relationship does not prove that CAPM is true. Roll's work did not refute the theory of CAPM, but showed that in fact it is impossible to be absolutely sure that the behavior of investors in the future will be identical to their intentions.

v. If the CAPM model was absolutely correct, it would have been applicable to all financial assets, including bonds. Experience shows that when bonds are introduced in the analysis, the points, reflecting their characteristics, do not lie on the SML. This is at least a cause for concern.

***Current state of CAPM***

CAPM concept is extremely attractive for theorists – it is logical and rational; specialists with sufficient mathematical education, usually accept it unconditionally. However, when given a thought, the assumptions underlying the model, raise some doubts, often reinforced by empirical tests of the model. Brigham and Gapenski (1990)[8] have the following point of view on the current state of CAPM:

i. The concept of CAPM, which is based on the priority of the market risk over the general risk is undoubtedly useful in providing the overall understanding of riskiness of assets in general, therefore, conceptually model has a truly fundamental value.

ii. Despite the fact that the CAPM at first glance gives clear and precise answers to questions about the relationship of risk and required rate of return, in reality it does not. The issue is that it is not known exactly how to estimate parameters included in

[7] Richard Roll 'A Critique of the Asset Pricing Theory's Tests'. The Journal of Financial Economics, issue March 1977, pp. 129-176.

[8] Brigham E.F., Gapenski L.C. 'Financial Management: Theory and Practice'. Thomson Learning, 2nd Edition (November 1993), pp. 92-94.

the model. It is assumed that a priori expected data (ex ante data) should be used, while only a posteriori actual values (ex post data) are available. In addition, the data on the market return, risk-free rate and beta vary considerably depending on the time periods observed and the methods used to evaluate them. Thus, although CAPM model seems adequate, its parameters cannot be measured accurately, so the estimates of returns using the CAPM potentially include significant errors.

iii. Since CAPM is logical in the sense that it reflects the behavior of investors seeking to maximize returns at a given level of risk and availability of all the necessary data, it provides a useful conceptual method. Of course, further attempts will be made to improve it and make it of a more practical significance.

iv. A major criticism of the CAPM has been made by Eugene Fama and Kenneth French from the University of Chicago. Fama and French (1992)[9] have studied the relationship between beta coefficients and asset returns for a few thousand shares on the time period of 50 years. According to CAPM, on average, stocks with high beta should generate higher returns than stocks with low beta. Nevertheless, the study found no relationship between the actual data – stocks with low beta had about the same yield as the stocks with high beta.

v. Many of the problems related to the financial side of the CAPM concept require detailed study. For the practical application of the model it is also important to be aware of its limitations.

## 1.3 CAPM with nonmarketable assets

One of the main prerequisites of CAPM is the homogeneity of investors' market portfolio. Mayers (1972)[10] suggested that these portfolios are not identical for different investors. He extended CAPM to include nonmarketable assets. As such he considered assets that possessed high value but with uncertain return, and which could not be traded according to the current legislation. Mayers introduced human capital as the main nonmarketable asset. He claimed that the covariance between the market portfolio and human capital explains the optimal weight of the market portfolio that different investors hold. In this paper, the author briefly covers the main aspects of Mayers model, its mathematical derivation and conclusions.

[9] Fama E., French K. 'The Cross Section of Expected Stock Returns'. The Journal of Finance, issue June 1992, pp. 427-465.
[10] David Mayers 'Nonmarketable Assets and Capital Market Equilibrium under Uncertainty'. Studies in the theory of capital markets, pp. 223-248, Praeger, New York, 1972.

The CAPM mean-variance assumptions are in place. It means, that every investor (single period) is assumed to be risk-averse, and have their own preferences on risk and return, mathematically described by the utility function: $G_i(E_i, V_i)$, where *Ei* is the one-period expected return and *Vi* is the variance of the *i*th investor's portfolio. Obviously, the function is upward-sloping by E and downward-sloping by V. To derive an equilibrium model the author solves the problem of maximization of the function *G* with appropriate constraints. It is assumed that assets are infinitely divisible, transactions are costless, and investors can lend and borrow funds at the risk-free rate. Function *G* and its derivatives will not be a part of the final return calculations. However, they will define the variable that shows the allocation of funds between the risky and risk-free assets – the balance of risk and return for a particular investor[11].

$$E_i = \sum_{j=1}^{n} X_{ij} E(D_j) + E(D_i^H) - (1 + R_f) d_i$$

$$V_i = \sum_{j=1}^{n} \sum_{k=1}^{n} X_{ij} X_{ik} \sigma_{jk} + \sigma^2(R_i^H) + \sum_{j=1}^{n} X_{ij} cov\left(R_i^H, R_j\right) \qquad (3)$$

and

$$W_i = \sum_{j=1}^{n} X_{ij} P_j - d_i \qquad (4)$$

Where

$X_{ij}$ is the share of company *j* held by investor *i*,

$D_j$ is the total (random) cash flow paid to the shareholders of company *j* at the end of the period,

$D_i^H$ is the total (random) cash flow paid to the investor *i* on nonmarketable assets (human capital) at the end of the period,

$\sigma_{jk}$ is the covariance/variance of the returns of the two assets *j* and *k*,

$R_f$ is the risk-free rate of return,

$d_i$ is the net debt of investor *i*,

$P_j$ is the total value of company *j* at the beginning of the period,

$W_i$ is the total wealth of investor *i* in the form of marketable assets at the beginning of the period,

*n* is the total number of firms in the economy.

[11] Alexander Bukhvalov 'Asymmetry between Insiders and Outsiders: the Problem of Duality of Companies' Assets Valuation', Russian Journal of Management, Vol. 6, No. 4 (2008), pp. 17-48.

Each investor solves the problem of maximization of $G_i(E_i, V_i)$ with the variables *Xij*, *di*, under the constraints described above. This classical problem is solved with the help of Lagrangian equation. As a result, we arrive at the following equations for the expected return of a marketable asset:

$$E(R_j) = R_f + \lambda\left[V_M cov\left(R_j, R_M\right) + cov\left(R_j, D_H\right)\right] \quad (5)$$

$$\lambda = \frac{E(R_M) - R_f}{V_M \sigma_M^2 + cov\left(R_j, D_H\right)}$$

Where λ is the market price paid for the unit of risk, $D_H$ is the total payoff to all nonmarketable assets in economy, $R_j$ is the return on asset $j$, $\sigma_M^2$ is the standard deviation of the market returns, and $V_M$ is the total value of marketable assets.

The key features of Mayers model can be summarized as follows[12]:

3. Unlike CAPM, investors hold different portfolios of risky assets as their nonmarketable asset has its own risk;
    a. If an investor does not hold a nonmarketable asset, his portfolio of risky assets matches the market portfolio as in CAPM, but anyway this investor will also have a different beta now, because beta does not depend on particular investors;
    b. If the return on nonmarketable assets is certain for every investor, the model will simply resemble traditional CAPM;
    c. Investors with nonmarketable assets modify market premiums in such a way so that the higher priority is given to the market assets, which have the lowest covariation with the nonmarketable assets;
4. Just like in CAPM, market prices do not depend on the indifference curves of investors. The formula (5) does not even contain the *i* index, which is representative of an investor;
5. Just like in CAPM, the risk is measured in terms of covariation, although now with two portfolios – of marketable and nonmarketable assets.

The first property basically means that in the Mayers model the Capital Market Line[13] (CML) does not exist. Nevertheless, an analogue of SML exists and the risk premium is either

[12] Copeland T.E., Weston J.F., Shastri K. 'Financial Theory and Corporate Policy', Pearson Addison Wesley (Boston, MA), 2005.

higher or lower than for the traditional CAPM, depending on the sign of *cov (Rj, $D_H$)*. The *1c* property plays a key role as a base for the decisions on diversification.

Let $\beta*$ denote the following coefficient:

$$\beta_j^* = \frac{V_M cov(R_j, R_M) + cov(R_j, D_H)}{V_M \sigma_M^2 + cov(R_M, D_H)} \quad (6)$$

Then Mayers model can be rewritten in the form of CAPM as:

$$E(R_i) = R_f + \beta_j^* \left[ E(R_M) - R_f \right] \quad (7)$$

$\beta*$ – the measure of sensitivity to the market – represents the key element of the model. It is reasonable to compare the $\beta*$ in (9) against the traditional CAPM $\beta$ in (2). The main difference is that the $\beta*$ in (9) contains additional component which represents covariation between the market portfolio and the nonmarketable asset in the denominator. Intuitively, this covariation should be positive, i.e. the value of the nonmarketable asset should grow as the market grows and vice versa. Moreover, (9) incorporates two types of measures with different dimensions: *R*, which is measured in fractions of a unit, and $D_H$, which is measured in monetary units. Thus, knowing the aggregate value of nonmarketable assets, $V_H$, we can rearrange $cov(R_M, D_H) = V_H cov(R_M, R_H)$.

Plugging the aforementioned rearrangement into (6), we arrive at the following formula for $\beta*$:

$$\beta_j^* = \frac{V_M cov(R_j, R_M) + V_H cov(R_j, R_H)}{V_M \sigma_M^2 + V_H cov(R_M, R_H)} = \frac{cov(R_j, R_M) + \frac{V_H}{V_M} cov(R_j, R_H)}{\sigma_M^2 + \frac{V_H}{V_M} cov(R_M, R_H)} =$$

$$= \frac{\frac{V_M}{V_H} cov(R_j, R_M) + cov(R_j, R_H)}{\frac{V_M}{V_H} \sigma_M^2 + cov(R_M, R_H)} \quad (8)$$

[13] Capital Market Line, or CML, is the graphical representation of all possible combinations of a market portfolio and a risk-free asset, which can mathematically be described by the formula: $R_i = R_f + \sigma_i \frac{R_M - R_f}{\sigma_M}$, where *Ri* is the expected return on asset *i*, *Rf* is the risk-free rate, $R_M$ is the return on the market portfolio, *σi* is the standard deviation of asset *i*, and $\sigma_M$ is the standard deviation of the market portfolio

## 1.4 Empirical tests of CAPM with nonmarketable assets

***Fama, Schwert (1977) Human Capital and Capital Market Equilibrium***

The purpose of this paper is to determine whether, as an empirical matter, the Mayers model improves on the description of the pricing of marketable assets provided by the Sharpe-Lintner-Black (SLB) model

Since the interpretation of the risk-free rate $R_f$, and the premium per unit of risk $\left[E(R_M) - R_f\right]$ is the same in equations (7) and (1), the only difference between the expected return-risk equations of the Sharpe-Lintner-Black and Mayers models is in the measure of the risk of a marketable asset. Thus, one way to test whether the Mayers model improves on the description of the pricing of marketable assets is to estimate the differences $\beta_j^* - \beta_j$ between the Mayers and SLB risk measures for different classes of marketable assets.

One of the main contributions of Fama and Schwert (1977)[14] is the restatement of Mayers risk measure. In the Mayers model, $H_t$ is the aggregate income received at *t* by the labor force employed from *t – 1*. To get appropriate measures of the covariances of income with returns, the authors suggested that one must first abstract from any variation through time in aggregate income that just reflects changes in the size of the labor force. Fama and Schwert solve this problem by using income per capita of the labor force to measure the variation through time in the payoff to a unit of human capital. The measure of the labor force ($L_t$) is the seasonally adjusted total civilian labor force collected by the Bureau of the Census of the Department of Commerce. To estimate covariance between income and returns from time series data, one assumes that the bivariate distributions of the income and return variables are stationary through time, which implies that the marginal distributions of the variables are stationary. However, the distribution of per capita income is not stationary – income has an upward trend, and the autocorrelations of per capita income are close to one for many lags. The standard cure for this type of mean nonstationarity suggested by Fama and Schwert is to work with a differenced form of the variable[15]:

$$h_t = \frac{H_t\left(\frac{L_{t-1}}{L_t}\right)}{H_{t-1}} - 1 \qquad (9)$$

[14] Eugene F. Fama, G. William Schwert 'Human Capital and Capital Market Equilibrium'. Journal of Financial Economics 4 (1977), pp. 95-125, North-Holland Publishing Company.

[15] Income per capita is $\frac{H_t}{L_t}$. Therefore, the differenced form is obtained as $h_t = \left(\frac{H_t}{L_t}\right) \div \left(\frac{H_{t-1}}{L_{t-1}}\right) - 1$, which can be rewritten as (9).

Before going further with Fama and Schwert restatement of the beta, let us note that Mayers equation (8) can be rewritten in terms of $\beta_j$ as:

$$\beta_j^* = \frac{V_{M,t-1}cov(\tilde{R}_j;\tilde{R}_{Mt}) + cov(\tilde{R}_{jt};\tilde{H}_t)}{V_{M,t-1}\sigma^2(\tilde{R}_{Mt}) + cov(\tilde{R}_{Mt};\tilde{H}_t)} = \beta_j \frac{[1 + cov(\tilde{R}_{jt};\tilde{H}_t)/(V_{M,t-1}cov(\tilde{R}_j;\tilde{R}_{Mt}))]}{[1 + cov(\tilde{R}_{Mt};\tilde{H}_t))/(V_{M,t-1}\sigma^2(\tilde{R}_{Mt}))]} \qquad (10)$$

To work with the percentage change in per capita income $\tilde{h}_t$, the parameters $cov(\tilde{R}_{Mt};\tilde{H}_t)$ and $cov(\tilde{R}_{Mt};\tilde{H}_t)$ in (10) must be restated in terms of $\tilde{h}_t$. Interpret $H_{t-1}$ and $\tilde{H}_t$ as aggregate income earned at *t – 1* and *t* by $L_{t-1}$ the total labor force at *t – 1*. Looking forward from *t – 1*, which is the perspective of equations (1) and (7),

$$\tilde{H}_t = H_{t-1}(1 + \tilde{h}_t),$$

and (10) can be rewritten as

$$\beta_j^* = \beta_j \frac{\left[1 + \frac{\left(\frac{H_{t-1}}{V_{M,t-1}}\right)cov(\tilde{R}_{jt};\tilde{h}_t)}{cov(\tilde{R}_j;\tilde{R}_{Mt})}\right]}{\left[1 + \frac{\left(\frac{H_{t-1}}{V_{M,t-1}}\right)cov(\tilde{R}_{Mt};\tilde{h}_t)}{\sigma^2(\tilde{R}_{Mt})}\right]} \qquad (11)$$

Taking nonmarketable assets to be synonymous with human capital, Fama and Schwert estimate $\beta_j^* - \beta_j$ for portfolios of New York Stock Exchange (NYSE) common stocks and for portfolios of U.S. Treasury Bills and bonds. They find that the differences between the Mayers and SLB risk measures are small, at best. The authors attribute this finding to the fact that the relationships between the payoff to human capital and the returns on bonds and stocks are weak, so that any existence of nonmarketable human capital does not have important effects on risk for these two important classes of marketable assets. Fama and Schwert conclude that for bonds and common stocks, the extensions of two-parameter theory provided by the Mayers model are not of much consequence for describing the relationship between expected return and risk.

***Jagannathan, Wang (1996) Conditional CAPM and Cross-Section of Expected Returns***

Another important paper to consider is the research of Jagannathan and Wang (1996)[16], in which the authors used conditional model as opposed to static one. As claimed by Jagannathan and Wang, the researchers who have previously examined the conditional version of CAPM have not studied directly the ability of conditional model to explain the cross-sectional variation

[16] Jagannathan R., Wang Zh. 'Conditional CAPM and Cross-Section of Expected Returns'. The Journal of Finance, vol. LI, No. 1 (1996), pp. 3-53.

in average returns on a large collection of stock portfolios. For the purpose of their paper, Jagannathan and Wang derived both conditional model and the implied unconditional model of CAPM, and have shown that when conditional model holds, a two-factor model applies unconditionally – average returns on assets are jointly linear in the average beta and in the measure of beta instability over time.

It is important to mention that Jagannathan and Wang considered the return on human capital in the context of the return on aggregate wealth. They have noted that stock only form a small part of the total economy wealth and, therefore, other assets should be considered for assessing the systematic risk. Following Mayers assumption that human capital contributes a significant portion of the total capital in the economy, Jagannathan and Wang included human capital in their model. The authors also took a notice that in the structure of total monthly per capita personal income in the US during the period of 1959 – 1992 the share of dividend income was less than 3%, while at the same time the share of wages and salaries was more than 60%. This further proved the validity of considering payoff to human capital to measure returns on aggregate wealth more accurately.

Jagannathan and Wang pointed out that even though securities like mortgage loans are issued against future income and active insurance markets exist for hedging the risk of human capital (life and medical insurance, unemployment insurance), there is a significant difference between human capital and other physical assets owned by corporations. The idea is that, unlike other physical assets, from the use of which the entire cash flow is usually promised away by issuing financial securities, it is not the case for human capital, where only a portion of income is secured by mortgages. Therefore, the authors concluded that factors affecting return on human capital cannot be identified precisely by examining returns on such securities as mortgages. Growth rate of the per capita payoff to human capital in the economy was taken as a proxy for return on human capital, similar to the measure suggested by Fama and Schwert (1977) research. Even though Jagannathan and Wang arrive at this measure based on different lines of reasoning, the calculation is the same as in (9).

Further the measure of labor-beta is defined by the authors as:

$$\beta_i^{labor} = \frac{cov(R_i,h)}{\sigma^2(h)} \qquad (12)$$

Finally, Jagannathan and Wang introduced the so-called Premium-Labor (PL) model, which is assumed to hold for every asset *i*:

$$E[R_{it}] = c_0 + c_M\beta_i^M + c_{prem}\beta_i^{prem} + c_{labor}\beta_i^{labor} \qquad (13)$$

Where $c_M$, $c_M$, $c_{prem}$, and $c_{labor}$ are some constants;

$R_{prem}$ denotes yield spread between BAA- and AAA-rated bonds;

$\beta_i^M = \frac{cov(R_i,R_M)}{\sigma^2(R_M)}$ ;

$\beta_i^{prem} = \frac{cov(R_i,R_{prem})}{\sigma^2(R_{prem})}$ .

In their empirica1 research, authors use the returns on 100 portfolios created using the same methodology as in Fama and French (1992) paper. For each calendar year starting 1963, they first break down the firms into size groups (deciles) based on market value at the mid of the year. After that for each size group, the authors calculated beta coefficients of companies using 24 to 60 months of historic returns and CRSP value-weighted index as proxy for market index. They denoted these betas as pre-ranking beta estimates. Thus, authors arrived at 100 portfolios by sorting firms within each size group into beta deciles according to pre-ranking beta estimations.

The empirical test of Jagannathan and Wang model has shown that the unconditional model implied by conditional CAPM explains around 55% of the cross-sectional variation in average returns of 100 stock portfolios, when human capital is included, as compared to 1% explained by traditional static CAPM.

***Jagannathan et al (1996) CAPM with human capital: Evidence from Japan***

Ravi Jagannathan, Keiichi Kubota & Hitoshi Takehara (1996) also suggested that human capital is particularly important to consider in CAPM model. The claimed that payoffs to human capital form more than one third of the total wealth in developed countries.

The authors follow Fama and Schwert (1977) approach to return on human capital, taking growth rate in per capita labor income in economy as a proxy. Two betas were estimated in the model – one based on covariation of asset returns with stock index portfolio and the other based on covariation of asset returns with per capita labor income.

The difference of this paper from other papers discussed is that it compares the results obtained from estimating the model with human capital to the ones obtained from Fama and French (1992) three-factor model, instead of traditional SLM CAPM.

In their empirical analysis Jagannathan, Kubota and Takehara used data for Japanese market because they thought that human capital played a crucial role in its economic development. The authors have shown that human capital forms a crucial part of the total wealth in economy. Wages and salaries comprised more than 70% (¥251,996 billion) of the national income (¥355,799 billion) in Japan in 1991, while income from dividends contributed less than 3% (¥9,993 billion). These results are similar to those obtained by Jagannathan and Wang (1996) for the US market.

In their methodology, Jagannathan, Kubota and Takehara followed the approach by Jagannathan and Wang (1996). They applied the model with labor-beta to Japanese market, which yielded coefficient of determination of more than 60%. Thus, the authors concluded that including human capital in the standard CAPM substantially improves the performance of the model.

# Chapter 2. CAPM with nonmarketable assets in Russia

## 2.1 The data

***Definitions***

The income per capita of the labor force, henceforth called income, is defined as the average wage and salary disbursements to the unit of labor force in the economy, as computed by the Federal State Statistics Service of the Russian Federation. Monthly data for the years 2009 – 2015 are used.

The empirical task of this paper is to compare estimates of $\beta_j$ and $\beta_j^*$ of (2) and (11) for different marketable assets *j*. Estimates of $\beta_j$ and $\beta_j^*$ require time series of:

i. the total value of marketable assets,
ii. the return on the market portfolio of marketable assets, and
iii. returns for different classes of marketable assets.

MICEX value-weighted index[17] is considered as a proxy for the market portfolio, and the aggregate capitalization of all securities traded on Moscow Exchange also comprise the total value of marketable assets in economy. Portfolios of subsets of MICEX stocks provide the different classes of marketable assets for comparing estimates of $\beta_j$ and $\beta_j^*$.

In more detail, data on the end-of-month total market capitalization of MICEX stocks and values for MICEX index were obtained from ‘Investfunds’ database.

Estimates of $\beta_j$ and $\beta_j^*$ of (2) and (11) are eventually compared for companies of ten major sectors of economy[18]:

i. Oil & Gas,
ii. Finance,
iii. Telecommunications,
iv. Energy,
v. Consumer goods,
vi. Transportation,
vii. Chemicals,

[17] MICEX index is the value-weighted index of 50 most liquid stocks of Russia’s largest public companies.
[18] Only securities of the largest most liquid public companies were considered in the analysis. For the list of companies, refer Appendix 1.

viii. Metal & Mining,
ix. Automotive,
x. Innovations.

To calculate the returns on securities a return index (RI) is used. It shows a theoretical growth in value of a share for a defined period of time. Dividends are assumed to be re-invested for the purpose of purchasing additional shares at a closing price applicable on the ex-dividend date.

Return index is calculated using the measure called annualized dividend yield. This method adds an increment of 1/260th part of the dividend yield to the price each weekday. Ignoring market holidays, it is assumed that there are 260 weekdays in a year. The base date value of RI is 100, and is further adjusted in subsequent time periods using the formula:

$$RI_t = RI_{t-1} \times \frac{PI_t}{PI_{t-1}} \times (1 + \frac{DY_t}{100} \times \frac{1}{N}) \quad (14)$$

Where:

| | |
|---|---|
| $RI_t$ | is the return index on day t |
| $RI_{t-1}$ | is the return index on previous day |
| $PI_t$ | is the price index on day t |
| $PI_{t-1}$ | is the price index on previous day |
| $DY_t$ | is the dividend yield % on day t |
| $N$ | is the number of working days in the year (taken to be 260). |

The calculation ignores reinvestment charges as well as any taxes. Gross dividends are used for calculations where available. Closing prices for the respective periods are used to calculate return index.

Returns are calculated based on return index, using the traditional formula:

$$R_{j,t} = \frac{RI_{j,t}}{RI_{j,t-1}} - 1 \quad (15)$$

In the two-parameter portfolio model, which is the foundation of both the Mayers and SLB models, people invest in order eventually to consume. They evaluate investment payoffs in units of consumption goods and services. This implies that variables should be measured in real rather than nominal units. All of the results below are reported for real versions of the variables, where the real variables are the nominal variables deflated by the Consumer Price Index (CPI).

***Summary statistics***

Summary statistics section is divided into two parts: 1) market statistics, and 2) sector-specific statistics. The former describes economy-wide parameters such as market return, market capitalization, total payoff to human capital in the economy, count of labor force and wage per capita. The latter focuses on sector companies' performance.

*Market statistics*

Market returns at the end of each month in the observed period were calculated[19] as follows:

$$R_{M_t} = \frac{MICEX_t - MICEX_{t-1}}{MICEX_{t-1}} \qquad (16)$$

Where $MICEX_t$ and $MICEX_{t-1}$ are the values of *MICEX* index at *t* and *(t-1)* respectively, $t \in$ 31.12.2008 … 31.12.2015.

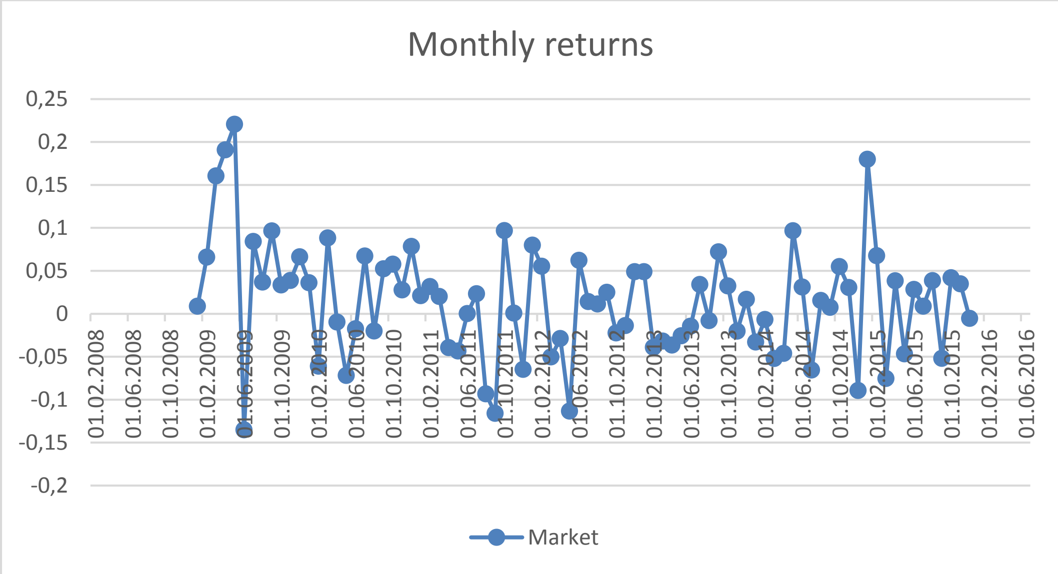
The mean value for market returns is 0.015, and median 0.018 (1.5% and 1.8%), while standard deviation is more than x4 times higher than the mean (6.5%). The same can be observed for $h_t$, with the same mean of 0.015, it has standard deviation of more than x7 times higher than mean (11.9%). Thus, one can say that these two measures are very volatile and the data should be checked for outliers.

Table 2.1.1 Summary statistics for market data

| | ***Rm*** | ***market cap, m*** | ***wage per capita*** | ***ht*** | ***labor force*** | ***total payoff to H, m*** |
|---|---|---|---|---|---|---|
| Mean | 0.015 | 24 936 094 | 26 761 | 0.015 | 70 844 062 | 1 899 321 |
| Standard error | 0.007 | 464 777 | 666 | 0.013 | 79 358 | 48 838 |
| Median | 0.018 | 25 195 296 | 26 652 | 0.011 | 71 229 715 | 1 902 658 |
| Standard deviation | 0.065 | 4 259 753 | 6 101 | 0.119 | 727 324 | 447 604 |
| Interval | 0.356 | 21 269 847 | 26 310 | 0.627 | 2 134 958 | 1 890 958 |
| Minimum | -0.135 | 10 643 790 | 17 098 | -0.276 | 69 410 458 | 1 209 472 |
| Maximum | 0.221 | 31 913 636 | 43 408 | 0.350 | 71 545 416 | 3 100 430 |

Source: Investfunds.ru, fedstat.ru, author's calculations

[19] Recall that the data was gathered on a monthly basis.




Pic. 2.1.1 Market returns, monthly data

As for other variables, the level of volatility is lower and standard deviations are much less than x1 mean. Market capitalization has the mean and median of around RUB 25 trillion, with a standard deviation of only RUB 4.26 trillion. Total payoff to human capital has the mean and median of RUB 1.9 trillion, with a standard deviation of 0.45 trillion. The lowest relative standard deviation is that of a labor force – with mean and median of 71 million, it has standard deviation of only 0.73 million.

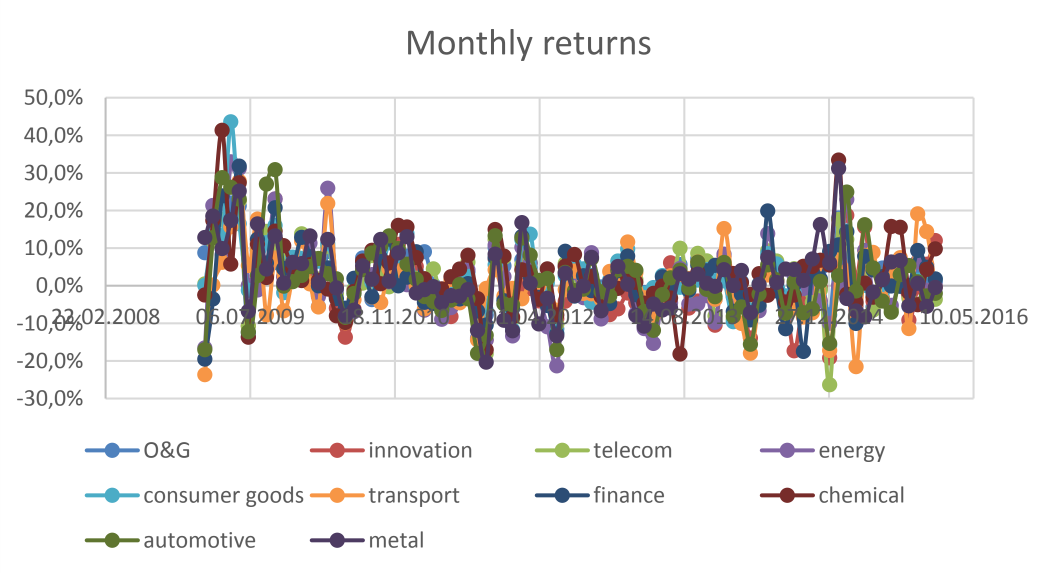
*Sector-specific statistics*

Table 2.1.2 Summary statistics for sector-specific data

| | ***O&G*** | ***innov*** | ***telec*** | ***ener*** | ***cons*** | ***transp*** | ***fin*** | ***chem*** | ***auto*** | ***metal*** |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.019 | -0.015 | 0.015 | 0.005 | 0.026 | 0.002 | 0.016 | 0.030 | 0.016 | 0.018 |
| Standard error | 0.007 | 0.008 | 0.009 | 0.011 | 0.009 | 0.010 | 0.010 | 0.010 | 0.011 | 0.010 |
| Median | 0.024 | -0.019 | 0.016 | -0.007 | 0.017 | -0.001 | 0.011 | 0.017 | 0.011 | 0.007 |
| Standard deviation | 0.064 | 0.069 | 0.081 | 0.099 | 0.080 | 0.088 | 0.088 | 0.092 | 0.100 | 0.088 |
| Interval | 0.356 | 0.379 | 0.489 | 0.542 | 0.594 | 0.514 | 0.514 | 0.595 | 0.489 | 0.515 |
| Minimum | -0.136 | -0.192 | -0.264 | -0.213 | -0.158 | -0.237 | -0.196 | -0.182 | -0.180 | -0.204 |
| Maximum | 0.219 | 0.187 | 0.225 | 0.329 | 0.435 | 0.277 | 0.318 | 0.413 | 0.308 | 0.312 |

Source: Investfunds.ru, author’s calculations

Graphical representation of returns time series for all ten sectors is given on Pic. 2.1.2. Besides high volatility, one can see that returns have similar patterns and, more importantly, resemble the behavior of market returns, which proves the validity of the chosen benchmark (MICEX index).



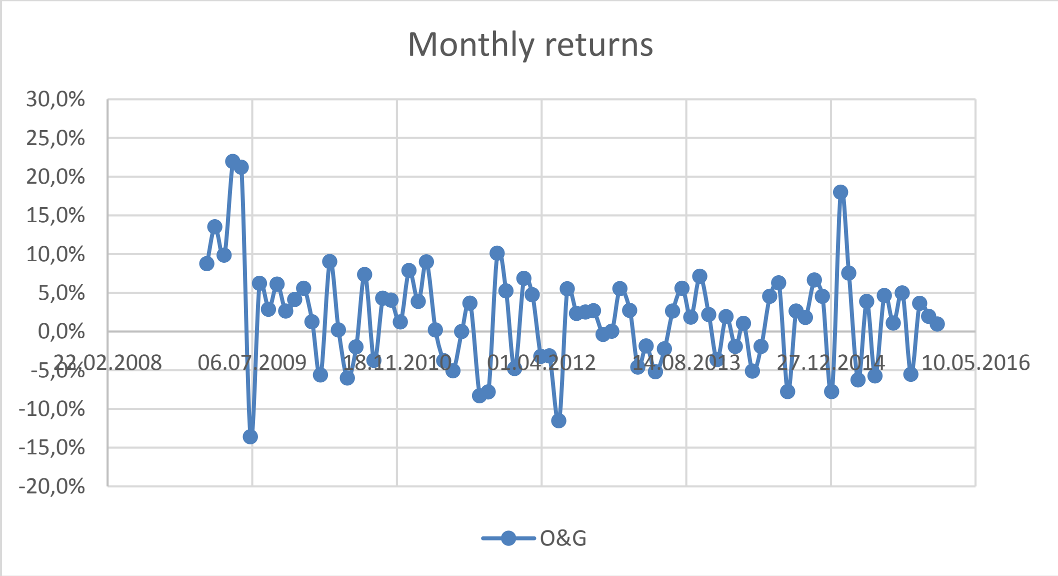

Pic. 2.1.2 Sector companies' returns, monthly data

No sector breakdown can be complete without Oil & Gas industry, which represents the key sector of the Russian economy. Most liquid companies that fell into the category of Oil & Gas are as follows:

i. Gazprom
ii. Rosneft
iii. Lukoil
iv. NOVATEK
v. Transneft
vi. Tatneft
vii. Surgutneftegaz
viii. Bashneft
ix. Slavneft-Megionneftegaz

These companies are also constituents of MICEX Oil & Gas index, and attribute to more than 90% of the Russian Oil & Gas sector turnover. They are considered to be highly representative of the sector.

With the mean return of 1.9% per month, standard deviation of the returns of companies in Oil & Gas sector reaches 6.4%, which makes it one of the least volatile sectors of the Russian economy.



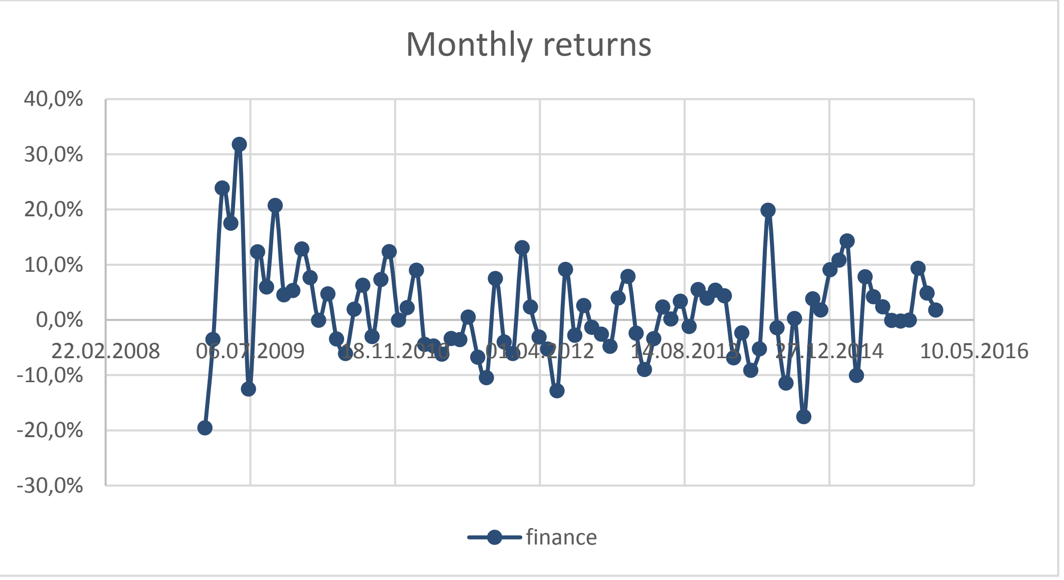

Pic. 2.1.3 O&G sector returns, monthly data

Financial sector is made up of such companies as:

i. Moscow Exchange
ii. Sberbank of Russia
iii. VTB
iv. AFK Sistema
v. Bank SPB
vi. Vbank

Although not numerous, these companies represent the lion part of the Financial sector. Sberbank and VTB alone control more than 50% of the commercial banking activities in Russia, and AFK Sistema is the largest financial conglomerate in Russia with the turnover of more than USD 35 billion. Thus, the sample can be treated as representative of the sector.

Mean monthly return level of the sector companies is at 1.6% with the standard deviation of 8.8%, showing the average volatility as compared to other sectors.

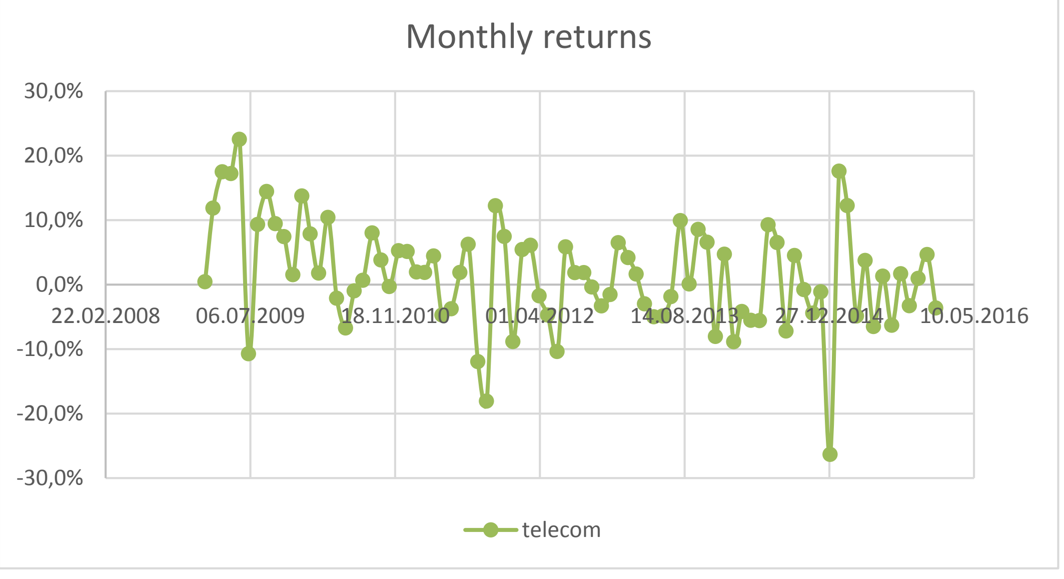



Pic. 2.1.4 Financial sector returns, monthly data

Telecommunications sector is represented by the following companies:

i. MTS
ii. Rostelecom
iii. Megafon
iv. MGTS
v. Central Telegraph

These include two of the three major mobile operators (MTS and Megafon) and the monopolist national long-distance service network (Rostelecom). Mean monthly return of the companies comprising this sector is 1.5% with the standard deviation of 8.1%.

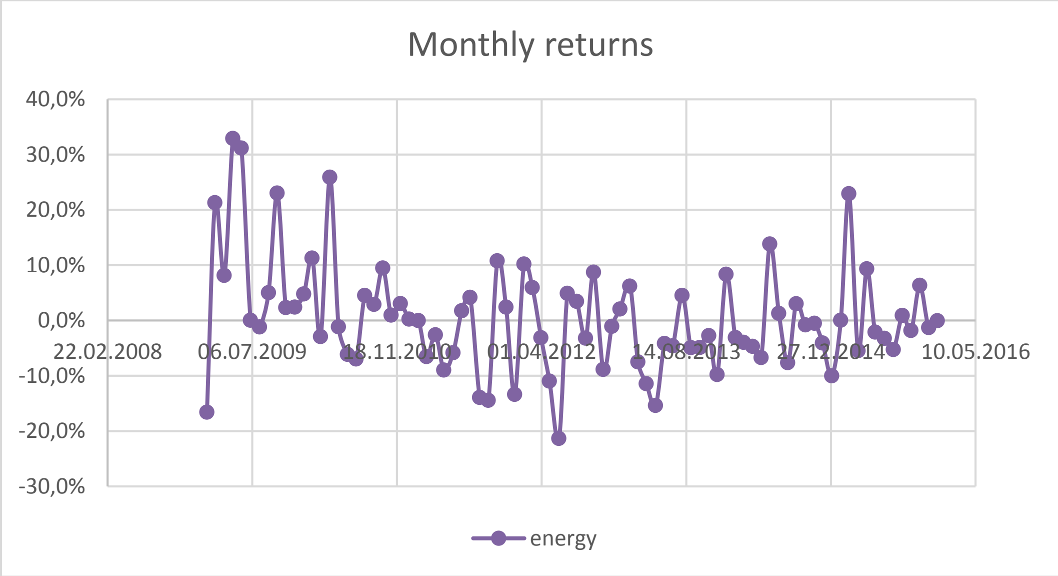



Pic. 2.1.5 Telecom sector returns, monthly data

Energy sector includes numerous entities, which appropriately represent the market:

i. FSK EES
ii. Interrao
iii. Eon Russia
iv. Rus Hydro
v. Rosseti
vi. Mosenergo
vii. OGK-2
viii. Irkutskenergo
ix. T Plus Group
x. Enel Russia
xi. MOESK
xii. TGK-1
xiii. MRSK-1
xiv. TNS Energo
xv. MRSK CP
xvi. MRSK Ural
xvii. MRSK Volgi
xviii. DVEC
xix. Quadra
xx. MRSK Yuga
xxi. MRSK Sevzap

This sector is highly volatile with standard deviation of 9.9%, which is x20 times higher than the mean monthly return of 0.5%.




Pic. 2.1.6 Energy sector returns, monthly data

Consumer goods is represented by the following companies, including major food and white goods retailers:

i. M.video
ii. Lenta
iii. Magnit
iv. Dixy Group
v. Ros Agro
vi. Cherkizovo Group
vii. Pharmstandard
viii. Protek
ix. Otcpharm
x. Razgulyai Group
xi. Russaquaculture

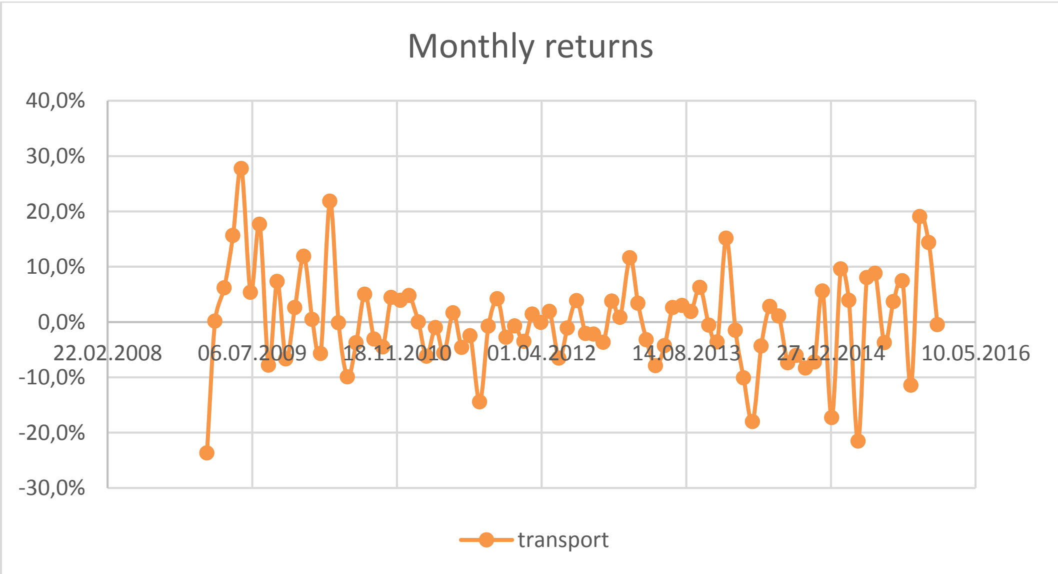
Consumer goods sector is characterized with one of the highest mean monthly returns of 2.6%, and with high standard deviation of 8%.


Pic. 2.1.7 Consumer goods sector returns, monthly data

For Transportation sector, the data is quite scarce. Only four liquid companies from different industries are traded on MICEX, including two airline and two transport operator companies:

i. AFLT
ii. Novorossiysk Commercial Sea Port
iii. Fesco
iv. Utair

The returns are extremely volatile, with monthly mean return of 0.2% and standard deviation of x44 times higher (8.8%).

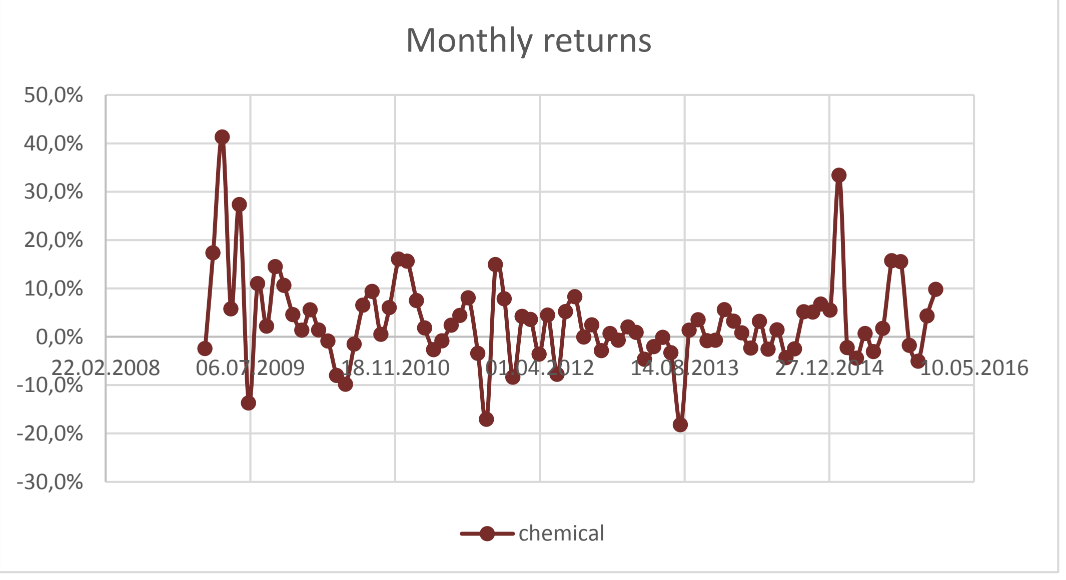


Pic. 2.1.8 Transportation sector returns, monthly data

Chemicals sector includes Russian largest chemical companies:

i. PhosAgro
ii. Uralkali
iii. Acron
iv. NKNH
v. Kazanorgsintez

The sector shows the highest average monthly returns of 3% with a standard deviation of 9.2%.




Pic. 2.1.9 Chemical sector returns, monthly data

Metal & Mining includes numerous largest representatives of the sector:

i. Severstal
ii. ALROSA
iii. GMK Norilsk Nikel
iv. Lipetsk NLMK
v. Polymetal International
vi. Polus Gold
vii. MMK
viii. RUSAL
ix. VSMPO-AVISMA

x. TMK

xi. Mechel

xii. Zinc

xiii. Raspadskaya

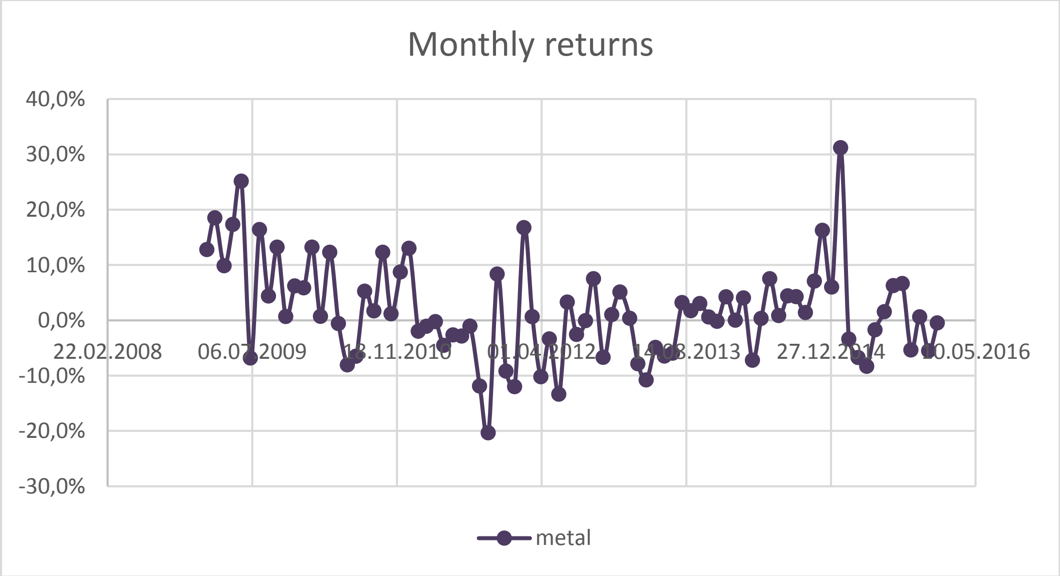
xiv. Kuzbasskaya Toplivnaya Company

xv. Len Zoloto

xvi. Chelyabinsk Metallurgicheskiy K

xvii. Amet

Mean monthly return of the sector companies is 1.8% with a standard deviation of 8.8%.




Pic. 2.1.10 Metals and Mining sector returns, monthly data

Only a few companies of Automotive sector are liquidly traded on MICEX, including:

i. Uniwagon

ii. Sollers

iii. AutoVaz (Lada)

iv. GAZ

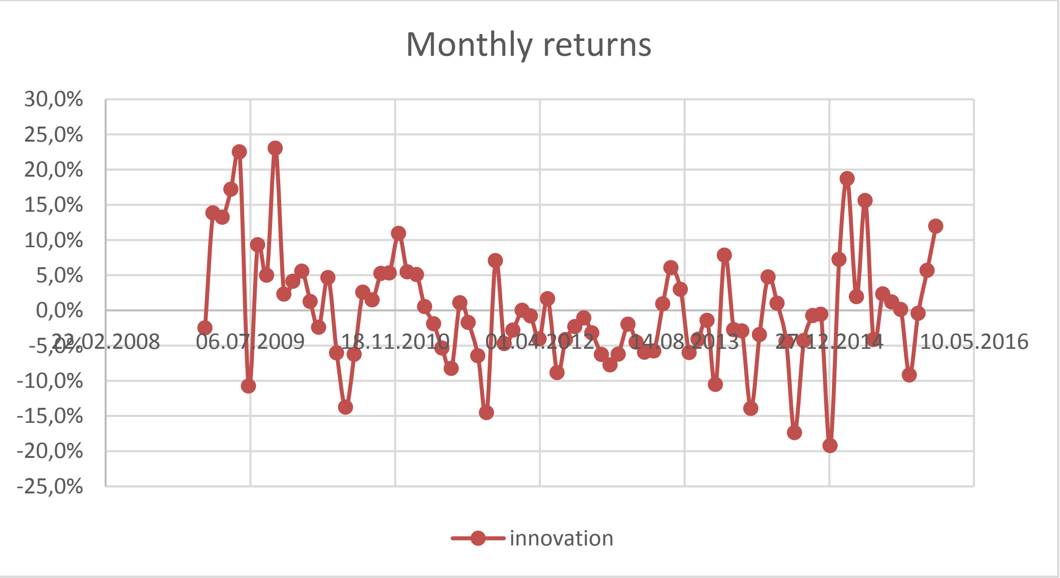
Mean monthly returns of these companies is 1.6%, while standard deviation amounts 10%.


Pic. 2.1.11 Automotive sector returns, monthly data

Innovations sector is extremely versatile and includes companies of a number of different industries:

i. Qiwi
ii. Human Stem Cells Institute
iii. Pharmsynthez
iv. United Aircraft Corporation
v. Donskoi Zavod Radiodetalei
vi. Multisistema
vii. Diod
viii. CZPSN-Profnastil
ix. Rollman Group
x. VTORRESURSY
xi. Nauka-Svyaz
xii. Levenhuk

These companies have shown negative average monthly return of -1.5% with a standard deviation of 6.9%.




Pic. 2.1.12 Innovation sector returns, monthly data

## 2.2 Econometric approach

***Econometric model***

One of the first stages of the econometric study is the classification of a model that uses panel data. Following types of models are known:

1. Pooled regression model:

$$y_{kt} = \beta_0 + \beta_1 x_{1kt} + \cdots + \beta_{m-1} x_{(m-1)kt} + \varepsilon_{kt} \quad (17)$$

Assumptions:

- All unknown parameters are constant for all groups of panel data at each point of time;
- The random component is assumed to satisfy Gauss-Markov conditions.

2. Fixed effect model:

$$y_{kt} = \alpha_{k0} + \beta_0 + \beta_1 x_{1kt} + \cdots + \beta_{m-1} x_{(m-1)kt} + \varepsilon_{kt} \quad (18)$$

It is assumed that there are deterministic individual effects for panel groups, modeled through $\alpha_{k0}$, i.e. the value of this ratio is different for each group. Thus, the model allows us to reflect the effects of variables that are not included in the study but characterize the features of the observed objects.

The main assumptions of the model ensure unbiasedness and consistency of estimates:

- Errors $\varepsilon_{kt}$ are not correlated with each other, $E[\varepsilon_{kt}] = 0$ and $V[\varepsilon_{kt}] = \sigma_k^2$
- Errors $\varepsilon_{kt}$ are not correlated with $x_{ikt}$ for all $i = 1 \dots m$, $k = 1 \dots n$ and $t = 1 \dots z$

The main disadvantage of this model is that it is not possible to identify the coefficients corresponding to the independent variables that do not change over time for each object (binary variables). Formally, this is because in such case in the equation for finding the fixed effect estimators of the parameters of the model[20], one or more regressors are equal to zero, and therefore, the ordinary least squares method (OLS) cannot be used.

3. Random effect model:

[20] Equation for the calculation of fixed effect estimators using OLS:

$$\hat{\beta} = \left[\sum_{i=1}^{n}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)(x_{it} - \bar{x}_i)'\right]^{-1} \times \sum_{i=1}^{n}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)(y_{it} - \bar{y}_i)$$

$$y_{kt} = \beta_1 x_{1kt} + \cdots + \beta_{m-1} x_{(m-1)kt} + \tilde{\varepsilon}_{kt} \quad (19)$$

This model has random individual effects, $\tilde{\varepsilon}_{kt} = \alpha_{k0} + \varepsilon_{kt}$. $\alpha_{k0}$ still reflects the impact of variables that are not included in the model, but it is now assumed that this effect is random with zero mean and equal variances for all sampling objects, wherein $\alpha_{k0}$ and $\varepsilon_{kt}$ are uncorrelated.

The selection of the most adequate model is done through pairwise comparison of the estimated models for each of the types mentioned above. The characteristics of these tests are presented in *Table 2.2*.

Table 2.2 Model selection tests

| **Test** | **Types of models compared** | **Main hypothesis** | **Alternative hypothesis** |
|---|---|---|---|
| Wald test | FE / pooled | $H_o: u_i = 0$ | $H_a$: at least one of the equations does not hold |
| Breusch – Pagan test | RE / pooled | $H_o: V[u_i] = 0$ | $H_a: V[u_i] \neq 0$ |
| Hausman test | RE / FE | $H_o: \rho_{xu} = 0$ | $H_a: \rho_{xu} \neq 0$ |

Source: Magnus J.R. Econometrics. Book – 5th Edition, 2001 – 400 p.

Following results were obtained for the observed data:

- P-value for Wald test is less than the level of significance, therefore, the main hypothesis $H_o: u_i = 0$ is rejected, preference is given to the model with fixed effect;
- P-value for Breusch–Pagan test is less than the significance level, the main hypothesis $H_o: V[u_i] = 0$ is also rejected, therefore, the random effects model is preferred to pooled regression;
- Using Hausman test to choose between the models with random effects and fixed effects, we accept the alternative hypothesis $H_a: \rho_{xu} \neq 0$. Thus, using the Wald test, Breusch-Pagan and Hausman the model with fixed effects was chosen.

***Test for statistical significance of results***

Although Fama and Schwert could not come up with any tests for statistical significance of the differences $\beta_j^* - \beta_j$, the author of this paper considers the introduction of such a test crucial for interpretation of the obtained results.

There are two types of tests in econometrics that are useful to consider in this case:

1. Test of the equality of the population means of two at least approximately normally distributed populations based on independent random samples with a) equal assumed variances, or b) unequal assumed variances.
2. Test of the mean difference of two populations based on dependent samples, or ‘paired comparisons’ test, assuming normal distribution.

Therefore, first it is important to identify whether there are grounds to suspect the dependence of samples of two betas. This dependence may stem from a factor that affects both sets of observations. At this point, the author considers the samples to be dependent because a substantial part of the calculation of the two betas is the same, and they both depend on market returns and asset returns, or more precisely their covariation. Based on this evidence, the author chooses to use the test for dependent samples.

Second, obviously there is a need to obtain samples of betas, which is achieved through running cross section regressions for each month of the observed period to obtain monthly betas and then calculate Mayers betas. Thus, the author gets 11 pairs of samples (for 10 sectors and market in general), each containing 83 observations.

After that, the author calculates t-statistic using formula (20) and compares it with critical value (from Student’s t-distribution) based on $(n-1)$ degrees of freedom and 5% level of significance. The following hypothesis are set:

$H_o\colon \mu_d = \mu_{dz}$

$H_o\colon \mu_d \neq \mu_{dz}$

$$t_{n-1} = \frac{\bar{d}-\mu_{dz}}{s_{\bar{d}}} \qquad (20)$$

where $\mu_d$ = mean of the population of paired differences

$\mu_{dz}$ = hypothesized mean of paired differences, which is zero for our case

$\bar{d}$ = sample mean difference = $\frac{1}{n}\sum_{i=1}^{n} d_i$

$d_i$ = difference between $i$-th pair of observations

$s_{\bar{d}}$ = standard error of the mean difference = $\frac{s_d}{\sqrt{n}}$

$s_d$ = sample standard deviation = $\left[\frac{\sum_{i=1}^{n}(d_i-\bar{d})^2}{n-1}\right]^{1/2}$

$n$ = number of paired observations

Finally, the obtained *t*-test should be compared to *t*-critical for a two-tailed test at 5% level of significance and with $(83-1)=82$ degrees of freedom, which equals 1.99. For the null hypothesis to be rejected the *t*-test should be greater than *t*-critical in absolute value, i.e. the following inequality must hold: $|t_{n-1}| > 1.99$

## 2.3 Statement of the results

The main part of the work is devoted to the calculation of two types of betas – regular and the one with human capital – and their difference. The statistically significant difference of the two risk measures would prove the validity and necessity of including nonmarketable assets in the traditional CAPM model, or vice versa. For the purpose of calculation of betas with human capital, equation (11) is used.

*Table 2.3* shows comparisons of estimates of $\beta_j$ and $\beta_j^*$ for the constituents of MICEX index[21], mentioned above (refer *2.1 The Data, Definitions*). The SLB risk estimates $\beta_j$ are the slope coefficients from market model regressions of $R_{jt}$ and $R_{Mt}$, where *M* is the value-weighted MICEX index. The estimates $\beta_j^*$ of the Mayers risk measure use the market model estimates for $\beta_j$ and the standard formulas for sample covariances and variances for the remaining parameters in (11). The ratio $\frac{H_{t-1}}{V_{M,t-1}}$ in (11) is estimated as the average of the monthly values of this ratio for the indicated period. *Table 2.3* gives the sample standard errors of the SLB risk estimates as well as *t*-statistics calculated for each pair of beta differences.

The question posed for *Table 2.3* is whether there are important differences between the Mayers and SLB risk measures for the marketable assets in general. The answer seems to be ‘no’. The difference is only as large as 0.0058 in absolute value.

[21] 50 most liquid stocks of Russia’s largest public companies. Refer *2.1 The Data, Definitions.*

However, even though one can infer from *Table 2.2* that the values of $\beta_j - \beta_j^*$ are close to zero for MICEX stocks in general, there may be subclasses of stocks for which there are important differences between the two risk measures.

For this reason, the stocks were divided into 10 major classes of assets (refer *2.1 The Data. Definitions*), and differences $\beta_j - \beta_j^*$ were calculated for each group, which has yielded some positive results. Yet, although for most classes the differences between the Mayers and SLB risk measures are close to zero and statistically insignificant, for Transportation and Innovation sectors the differences are as large as 8.5% and 9.2%.

Table 2.3 Statement of the results

| Portfolio | $\beta_j$ | $\beta_j^*$ | $\boldsymbol{\beta_j - \beta_j^*}$ | R-squared | Std. Err. | t-statistic |
|---|---|---|---|---|---|---|
| General | 0.9694 | 0.9636 | **0.0058** | 0.9311 | 0.0155 | 0.27 |
| Oil & Gas | 0.9199 | 0.9151 | **0.0048** | 0.8768 | 0.0345 | 0.14 |
| Innovation | 0.6694 | 0.7315 | **-0.0620** | 0.5776 | 0.0245 | -2.83 |
| Telecom | 1.0090 | 1.0139 | **-0.0049** | 0.7707 | 0.0709 | -0.17 |
| Energy | 1.2742 | 1.2708 | **0.0034** | 0.6074 | 0.1316 | 0.23 |
| Consumer good | 0.9947 | 0.9848 | **0.0100** | 0.5891 | 0.1066 | 0.09 |
| Transportation | 0.7021 | 0.7621 | **-0.0600** | 0.6230 | 0.0290 | -2.27 |
| Finance | 1.1018 | 1.0999 | **0.0019** | 0.6839 | 0.0563 | 0.03 |
| Chemicals | 0.9955 | 0.9966 | **-0.0010** | 0.4635 | 0.1370 | -0.11 |
| Automotive | 1.1984 | 1.2046 | **-0.0062** | 0.5893 | 0.1284 | -0.25 |
| Metals & Mining | 1.1232 | 1.0997 | **0.0235** | 0.6786 | 0.0494 | 0.48 |

Source: Stata regressions, author’s calculations

## 2.4 Interpretation of the results

Due to the nature of Russian economy, which is infrastructure-intensive and resource oriented, human capital plays in general a less significant role, than in more developed and innovation-oriented countries.

Therefore, it is not surprising that the effect from inclusion of human capital is negligible for the market in general and for the most sectors.

As for Innovation sector, the results that were obtained are meaningful, since this type of corporations usually is very dependent on personnel. Human capital plays a key role as a driver for innovations. The founders of the theory of human capital – H. Becker and T. Schultz – proved productive nature of the investments in people, providing a significant and lasting effect. For example, T. Schultz identified the formation of human capital with investments in education, which are realized in the enhanced production abilities and skills of employees, ensuring the growth of salary and employee satisfaction. At the micro-economic level, the formation of human capital is associated with the investment in personnel through the costs of education and training of the workforce, health care expenses, professional and geographical mobility.

Price of labor, emerging on the market, is an economic evaluation of human resources. The level of this estimate depends on the income of workers and employers costs. Economic evaluation, in turn, depends on the economic effect of the use of highly skilled human resources, determined by the level of their use. In the framework of the theory of human capital, efficiency of investments in the human resources is defined as the value of the additional returns resulting from the productive use of human resources.

As for Transportation sector, the author could not find any valid economic justification to explain why the results for this sector are significantly different from those of other eight sectors. In addition, given a more detailed look at the companies, comprising the sector, one can see that they are neither numerous nor representative of the sector, and operate in different segments of transportation. For this reason, Transportation sector was dropped from the analysis, and the results obtained were considered invalid.

## 2.5 Limitations

***Ways to define human capital***

There are many legitimate quarrels about the ways to measure the return to human capital. For example, in this paper the author uses gross income per capita as the measure of the payoff to a unit of human capital, while net income, that is, gross income less the maintenance costs that must be incurred to keep a unit of human capital in working order, is probably more appropriate. Implicit assumption made in the paper is that such maintenance costs are not highly related to the returns on marketable assets so that net income, is likely to be more or less unrelated to the returns on marketable assets [Fama and Schwert, 1977].

Another valid criticism is that working with per capita income corrects for changes in aggregate income that result from changes in the size of the labor force but it leaves any problems created by changes through time in the quality of the labor force. One of the ways of measuring the quality of the labor force is by median school years completed. Thus it seems reasonable to presume that the effects of quality change show up primarily in the mean rate of change of per capita income $\tilde{h}_t$, and that the variation through time of $\tilde{h}_t$, which is what is critical in the tests, is relatively free of the effects of quality changes.

Nevertheless, the rigor of the paper would be improved if all appropriate adjustments of aggregate income were made. Unfortunately, with the current state of data in Russia it is impossible to obtain such information.

***Human capital as a proxy for nonmarketable assets***

Prohibitions against slavery may not be sufficient to justify the assumption that human capital is nonmarketable. For example, athletic contracts and book publishing contracts involving bonuses or advances for future services can be regarded as partial sales of human capital. The same is true of borrowing with future income as the specific collateral. The Mayers model is quite clear on this point. The model allows unrestricted short selling of marketable assets, whether riskless or risky, but one cannot borrow specifically against future income. Such borrowing is in fact possible, although the amount that can be borrowed is usually less than one- or two-year income. Likewise, bonuses and other advances that amount to partial sales of human capital are not typical of the way payments are made to human capital. The extent to which human capital is marketable, then, is an open question [Fama and Schwert, 1977].

***Company data***

One can argue that the companies comprising sectors in this paper are not representative of the sector or scarce to make general conclusions. The author considers this point quite valid. However, the following points must be taken into account:

- The decision on assigning the stocks to certain sectors was based on the methodology of MICEX for choosing companies for sector indices;
- The most comprehensive data on the Russian stock market was used;
- With the current state of market data, it is not feasible to collect better data.

Considering the abovementioned, one can see that the limitation is rather caused by the market conditions than by the methods used in this research paper.

Nevertheless, increasing the number of companies for the study could be a good extension for further studies in this field in the future.

## Conclusions

In this paper, the author has presented and empirically tested the Capital asset pricing model with nonmarketable assets, namely human capital. The postulated relation between risk and expected return is of the same linear form as that of the Sharpe-Lintner-Mossin model. Thus, the structure of asset prices remains essentially the same even when nonmarketable assets are included in the investor's portfolio problem. However, the results differ from those of the SLM model in that the expanded measures of the firm's systematic risk and the market risk include the risk attributable to the existence of nonmarketable assets.

The formulation of the modified model is identical to the missing assets formulation of the SLM model – that is, ignoring the existence of nonmarketable assets in the expanded model leads to the same form of misspecification of the measure of relative systematic risk as does excluding portions of the universe of marketable assets in the SLM model.

Contrary to the SLM model, the expanded model implies that not all maximizing investors hold the identical (except for scale) portfolio of marketable assets. It implies that each investor holds a portfolio of marketable assets that solves his personal (and possibly unique) portfolio problem and, therefore, allows investors to maintain unique portfolios.

Empirical analysis of the CAPM with nonmarketable assets has shown significant difference of the estimates of the models for Innovations sectors. The beta predicted by extended model is 9.2% higher than the SLM beta. Unfortunately, the research has failed to prove the validity of the model for other sectors of companies and for the market in general, which may be attributable to the limitations stated in the paper. These limitations include: 1) the quarrels about the way to define human capital, 2) the controversy of using human capital as a proxy, and 3) the imperfection of data on Russian stock market.

For further researches on the topic, one could consider extending the definition of human capital by including other payments such as corporate trainings, social package, workplace infrastructure maintenance and other factors that comprise costs of maintaining a unit of human capital in the working order.

Finally, other types of nonmarketable asset may be elaborated. At this point, the work of Alexander Bukhvalov (2008) could be considered. Specifically, Professor Bukhvalov has suggested M&A volumes as a proxy for nonmarketable asset.

# References


1. Blume M., 1975 ‘Betas and Their Regression Tendencies’. The Journal of Finance, issue June 1975, pp. 785-796.

2. Brigham E., Gapenski L. ‘Financial Management: Theory and Practice’. Thomson Learning, 2nd Edition (November 1993), pp. 92-94.

3. Black, F., 1972 ‘Capital market equilibrium with restricted borrowing’. Journal of Business XLV, 444-454.
4. Bildersee, J., 1974 ‘Some new bond indexes: Extended and expanded results’. Rodney L. White Center for Financial Research, University of Pennsylvania, Philadelphia, PA, pp. 2-74.
5. Bukhvalov A., 2006 ‘Are Real Options Real?’ Russian Journal of Management, vol. 4 (2006), pp. 77-84.

6. Bukhvalov A., 2008 ‘Asymmetry between Insiders and Outsiders: the Problem of Duality of Companies’ Assets Valuation’, Russian Journal of Management, Vol. 6, No. 4 (2008), pp. 17-48.

7. Bukhvalov A., 2004 ‘Real Options in Management: Classification and Application’. Russian Journal of Management, vol. 2 (2004), pp. 27-56.

8. Bukhvalov A., 2004 ‘Real Options in Management: Introduction’. Russian Journal of Management, vol. 2 (2004), pp. 3-32.

9. Bukhvalov A., Volkov D., 2005 ‘Fundamental Value of Equity: Application of the Concept in Management’. Scientific Research No. 1-R-2005, St. Petersburg State University Research Institute of Management. Web-page: www.gsom.pu.ru/niim/publishing/papers/18

10. Bukhvalov A., Okulov V., 2006 ‘Classical Capital Asset Pricing Models and Russian Market. Chapter 1: Empirical tests of CAPM’. Scientific Research No. 36-R-2006, St. Petersburg State University Research Institute of Management. Web-page: www.gsom.pu.ru/niim/publishing/papers/44

11. Bukhvalov A., Okulov V., 2006 ‘Classical Capital Asset Pricing Models and Russian Market. Chapter 2: Opportunities for CAPM application’. Scientific Research No. 36-R-

2006, St. Petersburg State University Research Institute of Management. Web-page: www.gsom.pu.ru/niim/publishing/papers/44

12. Brealey R., Myers S. ‘Principles of Corporate Finance’. Olymp-Business, 2nd edition, 2010 – 977 p.

13. Breeden D., Gibbons M., Litzenberger R., 1989 ‘Empirical Tests of the Consumption-Oriented CAPM’. Journal of Finance № 44 (1989), pp. 231-262.
14. Copeland T.E., Weston J.F., Shastri K. ‘Financial Theory and Corporate Policy’, Pearson Addison Wesley (Boston, MA), 2005.

15. Fama E., Schwert W., 1977 ‘Human Capital and Capital Market Equilibrium’. Journal of Financial Economics 4 (1977), pp. 95-125, North-Holland Publishing Company.

16. Fama E., French K., 1992 ‘The Cross Section of Expected Stock Returns’. The Journal of Finance, issue June 1992, pp. 427-465.

17. Fama, E.F. and J. MacBeth, 1974 ‘Tests of the multiperiod two-parameter model’. Journal of Financial Economics 1, 43-66.

18. Fama E., French K., 1996 ‘Multifactor Explanations of Asset Pricing Anomalies’. The Journal of Finance, vol. LI (1996), pp. 55-84.
19. Fama, E.F., 1976 ‘Foundations of finance’. Basic Books, New York.
20. Fama, E.F., 1975 ‘Short-term interest rates as predictors of inflation’. American Economic Review LXV, 269-282.
21. Fama, E.F., 1970 ‘Multiperiod consumption-investment decisions’. American Economic Review LX, 163-174.
22. Fama, E.F. and M. Miller, 1972 ‘The theory of finance’. Holt, Rinehart and Winston, New York.
23. Jagannathan R., Wang Zh., 1996 ‘Conditional CAPM and Cross-Section of Expected Returns’. The Journal of Finance, vol. LI, No. 1 (1996), pp. 3-53.

24. Jensen, M.C., 1972 ‘Capital markets: Theory and evidence’. Bell Journal III, 357-398.
25. Levy R., 1971 ‘On the Short-Term Stationarity of Beta Coefficients’. Financial Analysts Journal, issue November 1971, pp. 55-62.

26. Lintner, J., 1965 ‘The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets’. The Review of Economics and Statistics, Vol. 47, No. 1 (Feb., 1965), pp. 13-37.
27. Markides C., Williamson P., 2008 ‘Related Diversification, Core Competences and Corporate Performance’. Russian Journal of Management, vol. 6 (2008), pp. 65-88.
28. Mayers D, 1972. ‘Nonmarketable Assets and Capital Market Equilibrium under Uncertainty’. Studies in the theory of capital markets, pp. 223-248, Praeger, New York (1973).
29. Official web page of the Russian Federal State Statistics Service, 2016. Url: https://fedstat.ru/
30. Richard R., 1977 ‘A Critique of the Asset Pricing Theory’s Tests’. The Journal of Financial Economics, issue March 1977, pp. 129-176.
31. Sharpe W., 1964 ‘Capital Asset Prices – A Theory of Market Equilibrium under Conditions of Risk’. The Journal of Finance, Vol. XIX (Issue 3) 1964, pp. 425–442.
32. Wooldridge J. ‘Introductory Econometrics: A Modern Approach’. South-Western College Publishing, 4th Edition.

# Appendices

Appendix 1. List of companies by sector

| **Oil & Gas** | **Energy** | **Metals & Mining** |
|---|---|---|
| Gazprom | FSK EES | Severstal |
| Rosneft | Interrao | ALROSA |
| Lukoil | Eon Russia | GMK Norilsk Nikel |
| NOVATEK | Rus Hydro | Lipetsk NLMK |
| Transneft | Rosseti | Polymetal International |
| Tatneft | Mosenergo | Polus Gold |
| Surgutneftegaz | OGK-2 | MMK |
| Bashneft | Irkutskenergo | RUSAL |
| Slavneft-Megionneftegaz | T Plus Group | VSMPO |
| **Innovations** | Enel Russia | TMK |
| Qiwi | MOESK | Mechel |
| Human Stem Cells Institute | TGK-1 | Zinc |
| Pharmsynthez | MRSK-1 | Raspadskaya |
| United Aircraft Corporation | TNS Energo | Kuzbasskaya Toplivnaya Company |
| Donskoi Zavod Radiodetalei | MRSK CP | Len Zoloto |
| Multisistema | MRSK Ural | Chelyabinsk Metallurgicheskiy K |
| Diod | MRSK Volgi | Amet |
| CZPSN-Profnastil | DVEC | **Transportation** |
| Rollman Group | Quadra | AFLT |
| VTORRESURSY | MRSK Yuga | Novorossiysk Commercial Sea Port |
| Nauka-Svyaz | MRSK Sevzap | Fesco |
| Levenhuk | Lenenergo | Utair |
| **Consumer Goods** | **Telecom** | **Finance** |
| M.video | MTS | Moscow Exchange |
| Lenta | Rostelecom | Sberbank of Russia |
| Magnit | Megafon | VTB |
| Dixy Group | MGTS | AFK Sistema |
| Ros Agro | Central Telegraph | Bank SPB |
| Cherkizovo Group | **Chemicals** | Vbank |
| Pharmstandard | PhosAgro | **Automotive** |
| Protek | Uralkali | Uniwagon |
| Otcpharm | Acron | Sollers |
| Razgulyai Group | NKNH | AutoVaz (Lada) |
| Russaquaculture | Kazanorgsintez | GAZ |