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A HIGHER MOMENT DOWNSIDE FRAMEWORK FOR CONDITIONAL AND UNCONDITIONAL CAPM IN THE RUSSIAN STOCK MARKET

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Abstract: The article presents an empirical validation for mean-variance CAPM, using a Downside and Higher-moment framework of CAPM in the Russian stock market. The authors test the unconditional and conditional CAPM specifications on a sample of weekly returns of the most liquid Russian stocks over the financially stable period of 2004-2007 and over the crisis period of 2008-2009. The primary contribution of this study is ranking the models with respect to their explanatory power of cross-sectional return variations. The unconditional classical CAPM (where market risk is approximated by the beta coefficient) is compared to the downside (mean-semivariance) CAPM extended to incorporate the third (skewness) and fourth (kurtosis) moments. The ranking methodology is based on Fama and MacBeth's (1973) two-stage estimation procedure. The unconditional CAPMs prove to have low explanatory power for the financially stable period and test results that are not statistically significant for the crisis period. Incorporating additional risk measures of the third and fourth moments and adopting one-sided risk measures only slightly increases the explanatory power. The highest explanatory power is offered by the unconditional CAPM of the Harlow-Rao downside systematic risk measure with zero benchmark. Our study confirms the feasibility of employing conditional CAPMs extended for systematic asymmetry (co-skewness) and systematic kurtosis (co-kurtosis) for the Russian stock market since these models display better explanatory power for cross-sectional return variations.

Keywords: Downside CAPM, Higher Moment CAPM, Conditional CAPM, Coskewness, Cokurtosis, Russian Stock Market
JEL Classification: G11, G12

1. Introduction

One of the main problems of portfolio managers investing in emerging capital markets is predicting market returns and explaining cross-sectional return variations. The Capital Asset Pricing Model (CAPM)[1], like the market equilibrium two-parameter return distributions model of capital assets pricing, develops a relationship between the systematic risk of an asset, measured as market beta, and the expected rate of return on that asset. The CAPM has become an integral part of nearly all textbooks on financial economics. Since the 1970s a number of studies have examined the background of CAPM and the explanatory power of one factor market

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[1] Sharpe (1965), Lintner (1966), Black (1972)

models in various markets and under different financial and economic conditions. The main idea of CAPM is to estimate return through the Mean-Variance Analysis framework, with risk measured from a portfolio viewpoint. This two-parameter model states that no measure of risk, other than portfolio risk, systematically affects average returns. The model's assumption is the normality of the distribution of one-period percentage returns on all assets and portfolios (Fama and MacBeth, 1973). Investors are assumed to be risk averse and to behave maximize expected utility.

The most common application of the CAPM is to estimate the expected and required return on equity, which is used for financial asset valuation, capital budgeting, portfolio performance evaluation and in setting regulated returns. CAPM and its beta measure of market risk are widely applied in practice.

Despite the enormous number of existing critical papers on reviewing the practical applications CAPM to many emerging and developed capital markets, investors, consultants and analysts for commercial non-financial companies continue using the traditional CAPM framework. A survey of the 11 Thousand financial directors which is regularly carried out by Duke University and CFO Magazine[2] had shown that in 2008 and 2009 nearly 75% respondents in asset valuation adhered to the CAPM framework. This model is described in every classic financial textbook[3] and in every investment company guideline on analytic reporting, using the DCF method for calculating a stock's intrinsic value (target price for investing). We can find quantitative beta estimations in leading databases such as Bloomberg, ValueLine, DataStream, Merrill Lynch.

Our study of the analytical reports of 37 investment companies working in the Russian capital market over a 10-year period reveals that DCF is the most preferred approach to calculating a company's fundamental value and the target price of its stock. As a rule, analysts employ expanded CAPMs (Hybrid CAPM, HCAPM) where a proxy for the country risk premium is added to the global market parameters (the risk-free rate and the market risk premium). The beta coefficient is set either equal to the average global estimate of the corresponding industry or equal to a professional estimate additionally adjusted for marketability of stocks and financial leverage of firms. When tested in the Russian capital market, HCAPMs thus specified display both a poor explanatory and a

[2] Graham, John; Campbell Harvey, Equity risk premium amid a global financial crisis, Evidance from the Global CFO Outlook survey 2009. SSRN WP; Graham, J. R., C. R. Harvey, 2009, The CFO Global Business Outlook: 1996-2009. http://www.cfosurvey.org

[3] Brealey, Richard; Stewart Myers; Franklin Allen Principles of Corporate Finance, 8th Edition, 2006, McGraw-Hill Inc.; Brigham, Eugene F.; Louis C. Gapenski; Phillip R. Daves, Intermediate Financial Management, Dryden Press, 6th Edition, 1999; Fabozzi, Frank; Pamela P. Peterson, Financial Management and Analysis, 2 Ed., Wiley Finance, 2003; Damodaran A. Equity Risk Premiums (ERP): Determinants, Estimation and Implications - The 2010 Ed. Stern School of Business, NYU, http://pages.stern.nyu.edu/~adamodar

poor predictive power of cross-sectional return variations. Therefore, we aim at testing alternative CAPM specifications where the original beta coefficient as a risk measure is replaced by a downside systematic risk measure or higher-order moments.

The Russian capital market is an emerging market with a lower level of capitalization and a low number of stocks which are listed and traded on the stock exchanges, low trading volumes and marketability. It is a market dominated by several large companies. Other important market characteristics, mean-variance-skewness and mean-variance-skewness-kurtosis, may cast serous doubts on the validity of results for the two-parameter linear model.

A number of researchers believe that the modification of CAPM (a two-parameter linear model with market beta factor that systematically affects expected returns) for emerging markets has to deal with not only the key model parameters (risk free rate, market risk premium, and beta coefficient) but also with the specific characteristics of the listed assets on these markets. An important consideration in applying CAPM is distinguishing between time periods when the model can be used (when higher systematic risk and higher returns on investment are correlated), and time periods when the assumptions of the model do not fit the external conditions and the model must be rejected.

To identify a model that would have a higher explanatory power of cross-sectional return variations in the Russian stock market, the following test steps were adopted.

We expanded the traditional two-moment model to include systematic mean-variance-skewness and mean-variance-skewness-kurtosis. Our hypothesis is that the inclusion of higher-order moments may better explain cross-sectional return variations.

We included a down-side risk measure in CAPM. We conjecture that accounting for the systematic downside deviation may improve explanatory power of cross-sectional return variations.

We replaced unconditional CAPM with conditional CAPM and compared specifications of various risk measures, both traditional, one-sided, and of higher-order moments. We hypothesize that the relation between risk and return become negative in a down-market (a market with a negative market risk premium).

One of the limitations of CAPM is that it takes into account only two moments of return distributions (mean and variance). Variance is a measure of risk that accounts for returns above and below the average return. We propose that the mean and variance do not fully represent systematic risk, as they do not indicate the risk that is related to any given stock on the emerging market. The two moments model is valid only under the following two assumptions: investors have a quadratic utility function, that is, an increase in the degree of risk aversion is accompanied by the growth of wealth (growth of wealth may cause risk aversion in emerging markets); the return distribution in normal (bell-shaped).

We propose that employing downside measures of risk (a mean-semivariance framework) has the following advantages for the Russian market: first, the negative volatility of returns is a concern for investors. Second, the semivariance is more useful than the variance when the underlying distribution of returns is asymmetric, or when the underlying distribution is symmetric; in other words, the semivariance is as useful a measure of risk as the variance. We suggest using the downside coefficient as a downside measure of systematic risk (as an indicator of negative sensitivity to market risk, the coefficient of downside co-skewness and the coefficient of systematic downside kurtosis).

2. Literature Review

According to a review of several markets (Harvey, 1995) the simultaneous requirements of symmetry and normality of the distribution of the expected stock returns are not achieved, leading to investors' concern about higher order moments (Rubinstein, 1973; Scott and Horvath, 1980). Risk associated with skewness and kurtosis can not be diversified by increasing the size of a portfolio (Gibbons et al. 1989), therefore skewness and kurtosis become important factors in asset valuation. Arditti (1971) and Francis (1975) show that total skewness as risk factor is not priced. The most extensively tested asset pricing model is the three-moment CAPM model of Kraus and Litzenberger (1976), which is preferable to skewness. The same results on systematic co-skewness are given in Lim (1989), who considered the American Stock Exchange from the 1950s to 1982. The author concludes that investors prefer positive systematic co-skewness. When the market is positively skewed there is no negative attitude to the systematic co-skewness even when the whole market is negatively skewed. Smith (2006) introduces systematic co-skewness as a measure of market risk in Fama and French's (1993) popular three-factor model and concludes that this improves the quality of the model as compared to the traditional three-factor model.

Many empirical investigations carried out since the 1970s that considered the effect of systematic skewness on asset pricing show a mixed result, depending on the choice of market portfolio and other conditions: Jean (1971), Arditti and Levy (1972), Ingersoll (1975), Lee (1977), Schweser (1978), Kane (1982), Lim (1989), Friend and Westerfield (1980), Sears and Wei (1988), Hwang and Satchell (1990), Harvey and Siddique (1999). Introducing systematic kurtosis and testing models with four moments of distribution has been done since the late 1980s: Homaifar and Graddy (1988), Fang and Lai (1997) and Iqbal et al. (2007), Cook and Rozeff (1984), Doan et al. (2009), Chi-Hsiou Hung (2007), Javid and Ahmad (2008), Javid (2009). These authors use different techniques for testing the influence of systematic co-skewness and co-kurtosis, including traditional linear, quadratic (Barone-Adesi, 1985) and cubic models (Ranaldo and Favre (2005), Christie-David and Chaudhry (2001), Chang et al. (2001), Hwang and Satchell (1999), Jurczenko and Maillet (2002), Galagedera et al. (2002)). Considering both the stock market and the derivatives market, these instruments do not arrive at a unique conclusion about the importance of this risk measure in assets pricing.

Doan et al. (2009) conducted a comparative analysis of the US and Australian markets to identify a model that would display a better explanatory power for cross-sectional return variations. In the authors' view the choice between models with systematic skewness and systematic kurtosis depends on the security profile as well as on the degree of investor risk aversion. Systematic skewness plays a more important role in explaining differences in stock price setting and differences in portfolio returns for the Australian market (statistically significant at 1%) while systematic kurtosis proves to be more important for the US market. Systematic kurtosis may be a significant factor for the Australian market depending on the size of the stock portfolio.

Two-parameter models do not distinguish between returns superior and inferior to the mean value. Several studies have shown that investors differently treat returns higher and lower than the mean and other benchmarks (the zero or risk free rate). Some studies proposed to take into account the asymmetry of returns and use downside risk measures in the CAPM. Downside beta is both intuitively and theoretically appealing, and empirically can provide a better risk measure than the traditional beta (Post and van Vliet (2004), Pederson and Hwang (2003)). Hogan and Warren (1974) in a theoretical framework and Jahankhani (1976) in an empirical study compared mean-variance and mean-semivariance pricing models and observed no difference in the two models in terms of linear association between expected return and beta. Bawa and Lindenberg (1977), Harlow and Rao (1989), Estrada (2002, 2007) reveal that downside risk measures have advantages over the standard risk measures in explaining variability in the cross-section of returns in emerging markets.

The semivariance CAPM (*SV CAPM*) of Hogan and Warren (1974) is written as follows:

$$E(R_i) = R_f + \frac{CSV(R_{m,}R_i)}{SV(R_m)} \cdot (E(R_m) - R_f),$$

where $E(R_i)$ is the required return on asset *i*, R_f is the risk free rate, $E(R_m)$ is the average market return, $R_m - R_f = MRP$, $SV(R_m)$ is the market's semivariance of returns, $CSV(R_m, R_i)$ is the cosemivariance between the market return and the return on asset *i*. The risk free rate (R_f) is considered to be the target rate (benchmark).

The distinctive features of the models considered by Hogan and Warren (1974), Harlow and Rao (1989) and Estrada (2002, 2007) models are in how they estimate cosemivariance:

Hogan and Warren (1974):

$$CSV(R_m, R_i) = E\left[(R_i - R_f) \cdot Min(MRP, 0)\right]$$

Estrada (2007):

$$CSV(R_m, R_i) = E\left[Min\{R_i - \mu_i, 0\} \cdot Min\{R_m - \mu_m, 0\}\right]$$

We estimate the risk measures and risk premiums for conditional CAPM in the Russian equity market as a number of studies have proved that testing CAPM for periods of positive and negative excess market returns is incorrect. Pettengill et al. (1995) observe that the investigations of beta and tests of cross-sectional return variations that use realized return as a proxy for expected return may have been biased due to the aggregation of positive and negative excess market return periods. The authors assume that in periods where excess market returns are negative, an inverse relationship between beta and returns should exist. Their empirical investigation of U.S. data reveals a positive slope on beta in the "up market" and a negative relationship in the "down market". The sample period for this study extends from January 1926 through December 1990. A similar result is arrived at by Friend and Westerfield (1980). They examine beta and co-skewness in the up- and down-markets and report that while beta is significant in both markets and its signs are consistent with the CAPM theory, the co-skewness is statistically significant in regression models only in the "up-market".

Chiao et al. (2002) present a comprehensive study of the risk-return characteristics of the Taiwan stock market, using monthly return data from January 1974 to December 1998 in up- and down-market conditions. The results show that investors expect a lower (higher) return when the distribution of stock returns demonstrates positive co-skewness (co-kurtosis). In addition, results show evidence of the relative importance of the co-skewness and the co-kurtosis risks, compared with that of the covariance risk in explaining stock return variations. This is particularly evident over the up-market subperiods.

Galagedera and Maharaj (2004) investigate the risk-return relationship with a conditional model using wavelet timescales in two-, three- and four-moment asset pricing on the Australian stock market. They indicate strong positive linear association between beta, co-kurtosis and portfolio return in the "up-market" and a strong inverse linear association between the beta, co-kurtosis and portfolio return in the "down market".

3. Methodology

We estimate the risk measures and risk premiums for different risk factors that are expected to determine asset prices in a local capital market (Russia) and explain cross-section return variations. We test the well-known capital asset pricing model (CAPM) with different specifications on individual stocks traded on MICEX, the main equity market in Russia. The procedure follows that of Fama and MacBeth (1973), Pettengill et al. (1995), Harvey and Siddique (2000), Chung et al. (2006): the risk factors of each individual stocks were first estimated and then a number of regression models were evaluated with regard to the level of explanatory power of cross-sectional return variations. The procedure works with multiple assets across time (time series data). The parameters are estimated in two steps. First we regress each stock against the proposed risk factors to determine that asset's beta for that risk factor. Betas are estimated using a time series regression framework. Then we regress (using one- and multi-factor models) all actual mean asset returns (*MR*) for a fixed time period against the estimated risk measures to determine the risk premium for each risk factor. Risk factors were proxied for by the traditional beta coefficient of the mean-variance approach, one-sided beta coefficients (mean-semivariance approach, downside beta), and higher-order moments of returns distribution (gamma and delta). We use cross-section regression to estimate the risk premium in one- and multi-factor models to test the adequacy of CAPM.

The one-factor tested equations are defined as follows:

$$MR_{it} = \lambda_0 + \lambda_1 \cdot risk\ \ factor + \varepsilon_{it}$$

The validity of mean-variance-skewness and mean-variance-skewness-kurtosis is tested as follows:

$$MR_{it} = \lambda_0 + \lambda_1 beta_i + \lambda_2 gamma_i + \lambda_3 delta_i + \varepsilon_{it}$$

We report that weekly estimation of model parameters is preferable when analyzing the Russian market. Weekly return is calculated as the difference between the closing price logarithm at the end of the week (Friday) and the closing price logarithm at the beginning of the week (Monday). If the needed data was missing, we used the closing price of the previous day.

The asset returns in the Russian stock market deviate from normality, indicating that investors are concerned about the higher moments of the return distribution. The first direction of investigation was to evaluate the extended CAPM with higher-order moments performance to explain the cross-section variation in expected returns across assets in the Russian stock market. First, we examine the relationship between equity return and higher-order moments as systematic risk factors. In our research we estimate four systematic risk factors: beta (as a traditional measure of risk), one-sided beta, the systematic skewness (co-skewness or gamma) and systematic kurtosis (co-kurtosis or delta) by using the following equations 1 -3:

$$\beta_{im} = \frac{E[(R_{it} - E(R_i))(R_m - E(R_m))]}{E(R_m - E(R_m))^2} \quad (1)$$

$$\gamma_{im} = \frac{E\left[(R_{it} - E(R_i))(R_m - E(R_m))^2\right]}{E(R_m - E(R_m))^3} \quad (2)$$

$$\theta_{im} = \frac{E\left[(R_{it} - E(R_i))(R_m - E(R_m))^3\right]}{E(R_m - E(R_m))^4} \quad (3)$$

The next step of the first direction is the cross-sectional analysis. We tested the regressions of mean returns (*MR*) for selected time periods (2004-2007, 2008-2010, 2004-2010) against the estimated coefficients of beta, one-sided beta, gamma and delta (based on daily and weekly estimations). The cross-sectional analysis allowed us to estimate the risk premium that corresponds to each selected parameter of risk (the traditional beta coefficient, and one-sided betas with different specifications: HWbeta, HRbeta, Ebeta, gamma (co-skewness) and delta (co-kurtosis)) and to identify the significance of these model parameters.

Cross-sectional analysis based on single-factor, two-factor and three-factor models allows us to select the best model with the introduction of risk measures in explaining cross – sectional variations in returns of selected companies.

The first direction of our research was based on the unconditional CAPM constructions. In the second direction of our research, we examined the explanatory power of different specifications of downside risk models. We evaluated four different measures of downside systematic risk: the models of Bawa and Linderberg (1977) with BLbeta, Harlow and Rao (1989) with HRbeta, Hogan and Warren (1974) with HWbeta and Estrada (2007) with Ebeta and with three benchmarks marked as τ (the zero, risk free rate and the asset's mean return, denoted μ).

The cross-sectional analysis of models relating average stock's return and the estimated downside systematic risk measures allows us to rank the explanatory powers of various asset pricing models in a downside framework with different benchmarks. The analysis of downside models is based on one-factor models that include the downside beta or downside asymmetry (co-skewness), two-factors models that include the downside beta and co-skewness. We use the estimated risk factors according to the method of Harlow and Rao (1989), marked as HRbeta, HRgamma and HRdelta, and Estrada (2007), marked as Ebeta, Egamma, Edelta to report our results.

The third direction of the research involves testing the hypothesis that conditional models with accommodation of market movements demonstrate better results in explaining cross-sectional security returns than unconditional models in an emerging market such as

Russia. We examine how the explanatory power of the pricing models changes depending on periods of financial stability and crisis. First, we follow Harvey and Siddique's (1999) approach to test the two-moment conditional CAPM with conditional covariance. Then the conditional CAPM is extended by incorporating the third and fourth moments (co-skewness and co-kurtosis) of return distributions. The average risk premium is calculated for different test periods in the conditional framework. We ascertain that different models are better for different periods of economic stability.

Within the third direction of our research we test the hypothesis that the excess market return has asymmetric effects on the parameters of models depending on the sign of the market risk premium (*MRP*). This relationship is positive for a "growing" market (up market), and negative for a "down" (bear) market with a negative market risk premium, when the market returns are lower than the risk-free interest rate. Thus, there is an inverse relationship between the return of stocks and measures of risk (such as the traditional factor, beta, as well as higher order moments).

Our study tested the hypothesis of the existence of a systematic conditional relationship between stock returns in the Russian market and higher order moments, which is formalized as follows:

$$R_{it} = \delta_{0t} + \delta_{1t} k \beta_{im} + \delta_{2t}(1-k)\beta_{im} + \delta_{3t} k \gamma_{im} + \delta_{4t}(1-k)\gamma_{im} + \delta_{5t} k \theta_{im} + \delta_{6t}(1-k)\theta_{im} + \varepsilon,$$

where $k = 1$ when $(R_{mt} - R_{ft}) > 0$ and $k = 0$ when $(R_{mt} - R_{ft}) < 0$

Testing the conditional models for the periods 2004-2007 and 2008-2009 confirmed our assumption.

4. Empirical Results

Our research is based on the daily data of 50 financial assets of the Russian market (common stocks and preference stocks), that constitute 95% of the capitalization of the Moscow Interbank Currency Exchange (MICEX). This study analyzes a period of 6 years starting January 14th 2004 to January 14th 2010. The Moscow Interbank Currency Exchange index is considered to be the market portfolio. The effective return of Russian government short-term notes is considered to be the risk-free rate for given time periods. The selection of the best asset pricing model is based on the cross-section analysis of weekly returns. Table 1 presents data on the MICEX index to give a good idea of its dynamics.

Table 1. Indicators of Risk and Return on MICEX Index (Russia)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Average Weekly Volatility, %	6.83	4.87	3.75	4.20	4.89	3.01	5.15	2.88	9.67	6.32
Average Weekly Return, %	-0.50	1.09	0.42	0.92	0.14	1.19	1.01	0.21	-2.14	1.83
Average Annual Return, %	-25.50	57.60	21.8	47.70	7.00	60.5	51.60	10.9	-111.5	64.20
Sharpe Ratio (Weekly)	-0.09	0.21	0.0 9	0.19	0.00	0.38	0.18	0.05	-0.23	0.26
Sortino Ratio (Weekly)	-0.09	0.22	0.07	0.16	0.00	0.39	0.15	0.05	-0.23	0.24
Asymmetry	0.00	-0.44	-0.19	-0.94	0.24	-0.44	-0.63	-0.53	0.27	-0.11
Excess	0.51	1.67	0.09	4.93	1.98	2.11	3.36	2.03	8.65	0.62

The analysis of summary statistics of Russian companies' returns has shown that the distribution of the expected return is not simultaneously symmetrical and normal. Leptokurtosis, skewness and high volatility characterize the distribution of the Russian stock market. The same results have been observed in other stock markets (Harvey, 1995; Hussain and Uppal, 1998; Javid, 2009).

Table 2 shows the leptokurtosis of nearly all selected stocks[1]. We note that we present the top 10 companies with the highest level of capitalization as of the end of 2007 in order to demonstrate our results. The same situation is observed in 2008 to 2009. The majority of the companies demonstrate negative asymmetry (in 2004 to 2007, 25 financial assets out of 50, and 30 financial assets out of 50 in 2008 to 2010).

Table 2. Summary Statistics: January 2004 – December 2007 (Top 10)

Aseet's MICEX TIKER	Mean (in %)	St. Dev.	Sample dispersion	Excess kurtosis	Asym-metry	Jarque-Bera	P-value	Data begin
LKOH RM Equity	0.36	4.19	17.51	2.72	-0.12	59.71*	0.00	02.01.2004
SBER03 RM Equity	1.04	4.51	20.38	1.61	0.38	25.08	0.00	02.01.2004
SNGS RM Equity	0.09	4.78	22.81	2.87	-0.38	70.67*	0.00	02.01.2004
GMKN RM Equity	0.56	5.63	31.71	1.88	-0.26	30.36*	0.00	02.01.2004
SIBN RM Equity	0.27	4.36	19.00	1.59	-0.26	22.16*	0.00	02.01.2004
MTSI RM Equity	0.50	4.25	18.06	0.93	0.34	10.52*	0.01	02.01.2004
NLMK RU Equity	0.86	5.09	25.93	1.52	-0.71	14.09*	0.00	21.04.2006
CHMF RM Equity	0.91	4.41	19.48	1.35	-0.11	8.80*	0.01	24.06.2005

Notes: Significant at the 1 percent level, *Significant at the 5 percent level

The normality test was conducted using the Jaque-Bera statistic, which checks if both skewness and kurtosis are simultaneously equal to zero. The normality test proves that the normality hypothesis can be rejected at the 0.1 significance level (Table 2) and it is possible to say that the data do not follow this distribution (43 companies out of 50 in the period of financial instability and 49 during the crisis). Some studies propose to solve the problem of non-normal distributions by using either semi-variance frameworks or conditional capital asset pricing models. Traditionally the following advantages of downside risk measures have been suggested: investors are more concerned about the negative return volatility; it is not necessary to reach symmetric distribution when using the semi-variance. We propose to use the downside beta (as a market risk negative sensitivity factor) and the relevant asymmetry (skewness) as comprehensible systematic risk measures.

The calculated alternative measures of risk are shown in Tables 3 and 4 for the two periods of financial stability (2004-2007) and crisis (2008-2010).

Table 3. Risk Factors for the Period 2004-2007 (Top 10)

Aseet's MICEX TIKER	E(R_i)	Gamma	Delta	Gamma Estrada with τ=μ	Gamma Estrada with τ=0	Gamma HR with τ=μ	Gamma HR with τ=0
GAZP RM Equity	0.57	1.10	1.03	1.04	1.04	1.04	1.03
ROSN RM Equity	0.57	0.97	0.77	0.78	0.79	0.77	0.77
LKOH RM Equity	0.36	1.02	1.01	0.98	1.00	0.98	1.00
SBER RM Equity	1.04	0.69	0.89	0.84	0.76	0.84	0.75
SNGS RM Equity	0.09	1.12	1.17	1.12	1.19	1.11	1.18
GMKN RM Equity	0.56	1.11	1.22	1.20	1.21	1.20	1.20
SIBN RM Equity	0.27	0.85	0.60	0.71	0.72	0.69	0.70
MTSI RM Equity	0.50	1.03	0.70	0.78	0.77	0.77	0.76
NOTK RM Equity	0.86	4.02	0.80	1.06	1.03	1.04	1.01
CHMF RM Equity	0.91	0.54	0.81	0.76	0.73	0.72	0.68

Table 4. Risk Factors for the Period 2008- 2010 (Top 10)

Aseet's MICEX TIKER	E(R_i)	Gamma	Delta	Gamma Estrada with τ=μ	Gamma Estrada with τ=0	Gamma HR with τ=μ	Gamma HR with τ=0
GAZP RM Equity	-0.61	1.40	1.19	1.04	1.07	1.04	1.07
ROSN RM Equity	-0.06	1.11	1.09	1.09	1.08	1.08	1.07
LKOH RM Equity	-0.13	0.97	0.96	0.96	0.95	0.95	0.95
SBER RM Equity	-0.26	1.31	1.30	1.28	1.27	1.26	1.25
SNGS RM Equity	-0.39	1.11	0.79	0.68	0.70	0.67	0.70
GMKN RM Equity	-0.14	1.89	1.43	1.23	1.22	1.18	1.17
SIBN RM Equity	0.08	1.17	1.16	1.13	1.10	1.11	1.09
MTSI RM Equity	-0.64	0.68	1.12	1.29	1.30	1.28	1.30
NLMK RU Equity	-0.26	0.63	0.97	1.19	1.19	1.16	1.16
CHMF RM Equity	-0.61	-0.38	0.56	1.14	1.17	1.14	1.17

The standard CAPM framework uses the standard algorithm (regression link between the asset risk premium and the market risk premium) to calculate the beta for each company. This model gives poor results in the given time periods (Table 5). The cross-sectional analysis of the period from 2004 to 2007 shows a beta explanatory power of 0.5% (during the sample period R^2 equals 0.005 in one-factor regression models of weekly return for every asset). From 2008 to 2009 the explanatory power of beta is even less precise (R^2 equals 0.2%). Replacing the standard risk measure (beta) by the downside measures (βE and βHR) improves the explanatory power of the one-factor models for the period of economic stability 2004-2007. For the period from 2008 to 2010 there are no advantages of the downside risk measures to be seen. The best measure for the time period of sustainable economic development is the downside beta of Harlow and Rao (βHR*)* with benchmark (target return) $\tau=0$ (R^2 equal to 36.2%).

Table 5. Risk Premium for Traditional and Downside CAPM

$MR_{it}=\lambda_0+\lambda_1\beta+\varepsilon$				
		λ_0	λ_1	**Adj R^2**
2004-2007	**Estimate**	0.843	0.613	0.005
	P-value	0.005	0.12	
2008-2010	**Estimate**	0.7	0.067	0.019
	P-value	0.0	0.755	
$MR_{it}=\lambda_0+\lambda_1\beta E+\varepsilon$ with $\tau=\mu$				
2004-2007	**Estimate**	1.016	0.774	0.091
	P-value	0.009	0.099	
$MR_{it}=\lambda_0+\lambda_1\beta HR+\varepsilon$ with $\tau=\mu$				
2004-2007	**Estimate**	0.886	0.665	0.094
	P-value	0.004	0.096	
$MR_{it}=\lambda_0+\lambda_1\beta E+\varepsilon$ with $\tau=0$				
2004-2007	**Estimate**	1.189	1.033	0.357
	P-value	0.000	0.003	
$MR_{it}=\lambda_0+\lambda_1\beta HR+\varepsilon$ with $\tau=0$				
2004-2007	**Estimate**	0.999	0.874	**0.362**
	P-value	0.000	0.002	

The advantages of the risk measure based on co-skeweness are obvious during the period of financial and economical stability (2004-2007), which is shown in Table 6. Thus the explanatory power of single-factor models, where the skewness measure stands for a single factor, in the classical and the traditional approach is influenced by market conditions. In other words, results vary depending on when the model is tested. Of all the tested measures of downside risk that incorporate co-skewness, the downside co-skewness of Harlow and Rao (1989) and the downside co-skewness of Estrada with different versions of the target return, demonstrated higher values of R squared (AdjR^2) than models with a traditional co-skewness. The best explanatory power was demonstrated by the model with downside co-skewness within the Harlow and Rao

(1989) construction with benchmark equal to zero return (AdjR^2 = 0.275) - Table 6.

Table 6. Risk Premium for Downside Co-Skewness Model

$MR_{it}=\lambda_0+\lambda_1\gamma E+\varepsilon$ with $\tau=\mu$					***$MR_{it}=\lambda_0+\lambda_1\gamma HR+\varepsilon$ with $\tau=\mu$***				
Period		λ_0	λ_1	**Adj R^2**	**Period**		λ_0	λ_1	**Adj R^2**
2004-2007	**Estimate**	0.887	-0.655	0.074	**2004-2007**	**Estimate**	0.837	-0.609	0.079
	P- value	0.007	0.123			**P-value**	0.005	0.116	
$MR_{it}=\lambda_0+\lambda_1\gamma E+\varepsilon$ with $\tau=0$					***$MR_{it}=\lambda_0+\lambda_1\gamma HR+\varepsilon$ with $\tau=0$***				
Period		λ_0	λ_1	**Adj R^2**	**Period**		λ_0	λ_1	**Adj R^2**
2004-2007	**Estimate**	1.023	-0.873	0.262	**2004-2007**	**Estimate**	0.949	-0.812	**0.275**
	P-value	0.000	0.010			**P-value**	0.000	0.009	

Downside co-skewness measures in the frameworks of Harlow and Rao (1989) and Estrada (2007) with benchmarks equal to zero are statistically significant at the 5% level, while other factors of systematic risk are not important. We conclude from this analysis that, for the downside gamma factor as well as for the downside beta coefficient, the best results in explaining return variations in the Russian market are achieved by using zero as the target return (benchmark for investing).

Table 7. Risk Premium for Expanded Unconditional CAPM

		λ_0	λ_1	λ_2	λ_3	Adj R^2
		$MR_{it} - R_f = \lambda_0 + \lambda_1\beta + \lambda_2\gamma + \varepsilon$				
2004-2007	**Estimate**	0.253	0.052	0.088		0.038
	t-value	1.332	0.187	**1.262**		
2008-2010	**Estimate**	-0.663	-0.086	0.190		0.126
	t-value	-4.002*	-0.411	2.585*		
		$MR_{it} - R_f = \lambda_0 + \lambda_1\beta + \lambda_2\gamma + \lambda_3\delta + \varepsilon$				
2004-2007	**Estimate**	0.255	-0.067	0.090	0.112	0.039
	t-value	1.329	-0.111	1.267	0.221	
2008-2010	**Estimate**	-0.670	-0.029	0.207	-0.066	0.127
	t-value	-3.718*	-0.051	1.193	-0.110	

Notes: *Significant at the 5 percent level and ** significant at the 10 percent level
Computed on weekly data

Classical systematic skewness is statistically significant at the 5% level in single-and two-factor models, and the explanatory power of models using systematic asymmetry are relatively better than the other considered structures: Adj R^2 = 0.123 (AdjR^2 equals 12.3%) in the one-factor model and AdjR^2 = 0.126 in the two-factor model (Table 7). Thus, systematic skewness demonstrates the best predictive ability among the examined risk measures from 2008 to 2010.

Cross-sectional analysis of the four-factor model demonstrated that the risk premium associated with beta, gamma and delta are not statistically significant. Only the constant term is statistically significant at the 5% level (AdjR^2 = 0.127), which is much higher compared to the two-factor market model form 2008 to 2010 (AdjR^2 = 0.002) and slightly superior to the single-factor model that included gamma (AdjR^2 = 0.123). This is not sufficient to conclude that the four moment unconditional model is better than the traditional CAPM market model.

Therefore, the unconditional CAPM does not display a high explanatory capacity during 2004 to 2007 and is not applicable to the period 2008-2010. The introduction of co-skewness increases the explanatory power of CAPM.

Testing the conditional pricing models involves plotting two data sets: the period of positive excess market returns (when the market return is lower than the risk-free return) and the period of negative excess market returns (when the market return is higher than the risk-free return), denoted in Table 8 as “Up market” and ”Down market”).

Table 8. Risk Premium for Conditional CAPM

		Traditional conditions – positive MRP - "Up market"				Negative MRP - «Down market»			
		$MR_{it} - R_f = \lambda_0 + \lambda_1\beta + \varepsilon$							
		λ_0	λ_1	λ_2	AdjR^2	λ_0	λ_1	λ_2	AdjR^2
2004-2007	Estimate	1.279	0.825		0.148	-1.167	-1.017		0.189
	t-value	6.020*	2.888*			-4.914*	-3.343*		
2008-2010	Estimate	1.968	0.856		0.075	-2.352	-2.201		0.456
	t-value	5.502*	1.976**			-6.416*	-6.348*		
		$MR_{it} - R_f = \lambda_0 + \lambda_1\gamma + \varepsilon$							
2004-2007	Estimate	1.724	0.117		0.010	-1.638	-0.245		0.022
	t-value	10.853*	0.703			-7.022*	-1.029		
2008-2010	Estimate	2.060	0.800		0.087	-3.118	-1.708		0.375
	t-value	6.817*	2.143*			-10.315*	-5.371*		
		$MR_{it} = \lambda_0 + \lambda_1\gamma + \lambda_2\delta + \varepsilon$							
2004-2007	Estimate	1.357	-0.564	1.214	0.169	-1.492	0.317	-0.879	0.207
	t-value	7.093	-2.055	2.999		-6.264	0.868	-1.981	
2008-2010	Estimate	2.048	-2.628	1.781	0.112	-2.892	3.704	-5.669	0.449
	t-value	6.791	-1.591	1.136		-9.619	1.702	-2.511	

Notes: * Significant at the 5 percent level and ** significant at the 10 percent level

We ascertain that the down and up market behavior has a significant systematic asymmetric impact on the beta risk premium. According to the test results the beta-risk premium is positive in all models and statistically does not equal zero in the up market. However, it is negative and statistically significant at 5% in the down market as we have assumed.

The explanatory power of the two-moment CAPM (one-factor model) with the standard beta is considerably higher in the down market (average AdjR^2 equals 32% for the whole period in the down market) than in the up market (average AdjR^2 equals 11%).

The results of a negative weekly market premium in the down market turned out to be even more significant. For example, the explanatory power of the model that includes the standard beta is 46%, with beta statistically equal to 5% for the period from 2008 to 2009. The beta generally has shown a higher explanatory power in the down market than other higher order moments (gamma and delta) during both periods from 2004 to 2007 and from 2008 to 2009.

The results of the study show that the systematic skewness added to beta is not significant (we do not give these results due to their low explanatory power) in either the up or down markets (t statistic = -1.662 in the "up market" and 0.844 in the "down market" for the period of financial stability). However the risk premium of the systematic skewness is negative in the “up market” and positive in the “down market” as we have assumed.

It should be noted that the two-factor model includes co-skewness, and the co-kurtosis shows the best results by the “AdjR squared” criterion, and both factors are statistically significant (Table 8). On the “growing (Up) market” average $AdjR^2$ equals 14% for 2004-2010. On the “down market” average $AdjR^2$ is significantly higher (33%). The explanatory variables are significant, the gamma risk premium is negative in the “up market” and positive in the “down market”, the co-kurtosis risk premium is negative in the “down” and positive in the “up market” (Table 8), which confirms our hypothesis.

Finally, we estimate the risk premiums of the conditional four-moment pricing model. The results are reported in Table 9. The explanatory power of the four-moment conditional model is higher in the “down market” (with average adjusted R^2 36 percent) than in the up market (where average adjusted R^2 is equal to 17.5 percent). The beta and kurtosis risk premiums are negative, the co-skewness risk premium is positive, while risk factors are not statistically significant.

Table 9. Risk Premium for Four - Moment Conditional CAPM

«Up market»	$MR_{it} = \lambda_0 + \lambda_1\beta + \lambda_2\gamma + \lambda_3\delta + \varepsilon$					
		λ_0	λ_1	λ_2	λ_3	**$AdjR^2$**
2004-2007	**Estimate**	1.205	0.871	-0.508	0.544	0.210
	t-value	5.656	1.540	-1.859	0.922	
2008-2010	**Estimate**	1.667	1.871	3.120	-3.710	0.140
	t-value	3.869	1.229	1.845	-1.677	
«Down market»	$MR_{it} = \lambda_0 + \lambda_1\beta + \lambda_2\gamma + \lambda_3\delta + \varepsilon$					
2004-2007	**Estimate**	-1.098	-2.163	-0.216	1.278	0.239
	t-value	-4.243	-2.930	-0.561	1.515	
2008-2010	**Estimate**	-2.471	-1.382	2.729	-3.557	**0.480**
	t-value	-6.312	-1.639	1.229	-1.386	

Thus, while there is a reverse relation between the equity return and beta in all tested models in the down market during both time periods, the relation between the systematic skewness and return is negative during the crisis period and positive during the period of financial stability (2004-2007).

5. Conclusion

Our research is primarily aimed at identifying a model specification which best suits the Russian capital market with regard to the level of explanatory power of cross-sectional return variations. Our tests were performed on a sample of daily, weekly, and monthly returns of the 50 largest and most marketable Russian stocks (constituting 95% of the MICEX stock capitalization) over the period from 2004 to 2009. The procedure followed that of Fama and MacBeth (1973), Pettengill et al. (1995) and Harvey and Siddique (2000), that is, historical risk factors of every stock were first estimated and then a number of regression models were evaluated with regard to the level of explanatory power of cross-sectional return variations (we have estimated the cross-sectional relationship between the mean return of assets and risk factors for each period and then compared models). Risk factors were proxied for by the traditional beta coefficient of the mean-variance approach, downside beta coefficients, and higher-order moments of returns distribution (gamma and delta).

A comparison of models with different return intervals reveals that the best explanatory power is achieved by models with weekly returns. Price dynamics of the sample stocks and the performance of the index give evidence that the assumption of symmetrical and normal expected return distribution is not valid either in the short run (one year) or in the long run.

Traditional models where the market risk of assets is measured by the beta coefficient of the unconditional CAPM display statistically significant results only for segmented periods of economic development in Russia (2004-2007). None of the models with the CAPM beta coefficient or the one-sided beta coefficient is significant for the crisis period (2008-2009). The empirical results indicate that the traditional unconditional CAPM is inadequate for Russia's stock market in explaining cross-section return variations and the significant role of market risk for determining average return.

One of the hypotheses we tested states that downside risk measures (downside betas) are better for explaining cross-sectional return variations. Our tests show that the explanatory power does improve in terms of a higher coefficient of determination for the financially stable period of 2004-2007 if the traditional CAPM beta coefficient is replaced by one-sided risk measures. Also the tests support the supposition that, for the zero rate of return benchmark, the models display better explanatory power. The downside beta specification of Harlow and Rao (1989) proves to be more efficient in explaining cross-sectional return variations than that of Estrada (2007).

Another hypothesis that we tested states that the inclusion of higher-order moments (the gamma coefficient of systematic asymmetry and the delta coefficient of systematic kurtosis) may contribute to the explanatory power of one- and-multi-factor models. Our tests refute this hypothesis, except for the model with the Harlow and Rao (1989) one-sided beta coefficient with zero benchmark and gamma coefficient. This model displays a comparatively good explanatory power of cross-sectional return variations in the Russian stock market.

We explain the test results by the fact that the models bear an embedded assumption of the symmetric impact of risk on return in falling and rising markets. To complete the research we divided the sample period into two subperiods differing by the sign of the market risk premium (*MRP*), that is, a period with positive *MRP* (associated with a rising market) and a period of negative *MRP* (associated with a falling market). The conditional models, including those with higher-order moments, were tested in the rising and falling market. Again, the tests results are consistent with the hypothesis of the feasibility of conditional CAPM-based models that incorporate higher-order moments of distribution such as systematic asymmetry (co-skewness) and systematic excess (co-kurtosis).

To conclude, we note that the one-sided beta specification proves to be more feasible for explaining cross-sectional return variations in the Russian stock market relative to the traditional beta coefficient of mean-variance approach. Unconditional models expanded to include higher-order moments of distribution do not give evidence of any improvement in explanatory power. Conditional models best explain cross-sectional return variations. The higher-order moments of distribution (co-skewness and co-kurtosis) contribute to explanatory power.

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