Folia Oeconomica Stetinensia
DOI: 10.2478/v10031-009-0028-0

THE INFLUENCE OF NEGATIVE BETA ASSETS ON THE EMPIRICAL SML IN THE POLISH CAPITAL MARKET

Rafał Wolski, Ph.D.

Faculty of Economics and Sociology
University of Lodz
Rewolucji 1905 r. No. 41, 90-214 Lodz
e-mail: rwolski@uni.lodz.pl

Received 19 December 2008, Accepted 10 July 2009

Abstract

The classical approach to the SML assumes that it is a straight line, which means that an investor is willing to accept lower return on the negative beta assets than on the risk-free assets. However, Cloninger, Waller, Bendeck and Revere (2004) challenged this commonly accepted approach. The author of the paper decided to verify the approach using empirical data for years 1999-2006 obtained from the Warsaw Stock Exchange. Finance theoreticians believe that the SML is linear, which means that an investor buying negative beta assets is willing to accept lower return than in the case of a risk-free asset. Cloninger et al. (2004) formulated a hypothesis stating that the SML is V-shaped and that it is not a straight line. It was concluded that an investor had no reason to accept lower return of the negative beta assets; quite the contrary, the investor would expect the same return as on the positive beta ones. The author of this article performed an investigation for the Polish market, taking advantage of companies quoted at the Warsaw Stock Exchange. The investigation demonstrated that between 1999 and 2006, the SML had a V-like shape and thus the research hypothesis formulated in the article was positively verified.

Keywords: Security Market Line, negative beta, CAPM, capital market, cost of capital.

JEL classification: G12.

1. The Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model, introduced[1] independently by Treynor[2] (1961), (1962), Sharpe (1964), Lintner (1965), Mossin (1966) and Jensen (1968), assumes that a relationship exists between the variance (or standard deviation) of asset's return and the required return. The mathematical notation is given by formula 1 that describes the classical form of the Capital Asset Pricing Model (Sharpe 1964) (see also Figure 1).

$$\overline{R}_P = \overline{R}_w + \beta_P(\overline{R}_R - \overline{R}_w) \tag{1}$$

where:

$\overline{R}_P$ – expected return of investment portfolio „p",

$\overline{R}_R$ – expected return on a market,

$\overline{R}_w$ – expected return on risk-free assets,

β_P – beta coefficient for investment portfolio „p".

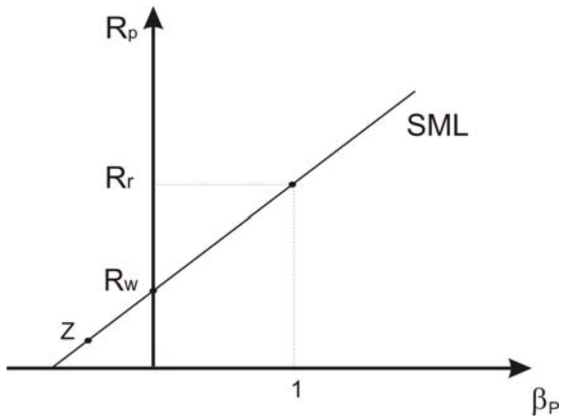

Fig. 1. The security market line
Source: Francis (1986) pp.779-784.

Although many researchers[3], leave out the negative beta problem, some works exist that recognize it, but the solution they provide involves the removal of certain observations from the study (Blog, Van Der Hoek, Rinnooy Kan, Timmer 1983). Consequently, an interesting instance is point „Z" where for the case of equilibrium the return is smaller than the return on risk-free assets. The capital market theory explains the phenomenon using Markowitz diversification. In an academic textbook, Francis describes the relatively high price of „Z" by means of negative correlation with the market, which allows investors to complement diversified portfolios (Francis 1986). The negative beta problem was acknowledged in Cloninger et al. research, where the authors proposed the modification of the classical CAPM. Asgharian and Hansson (2005) identified a similar problem in their work and, referring to earlier research papers by Fama and French (1992), introduced a three-factor CAPM to solve it.

2. The Security Market Line

Cloninger et al. published the paper discussing theory on the assumed linear nature of the SML. The authors demonstrate in their research that the negative beta assets are mistakenly viewed as those that must provide an investor with a low returns. They formulate a hypothesis that the classical, linear approach to the problem is incorrect and support it using empirical research and theoretical reasoning, where they indicate that investors' acceptance of a portfolio comprising securities negatively correlated with the market return does not mean that they are willing to accept negative returns on that portfolio. The authors openly state that this approach shows certain logical deficiencies and that the "V" shape of the function represented by the SML seems natural. The function would be formed as the mirror image of the right-hand side of the SML graph. No reason was found why an investor should accept different levels of return for assets carrying the same absolute values of risk. Continuing their discussion, Cloninger et al. deliberate, whether the treatment of investment portfolios with negative beta according to the notation of the CAPM equation is not the reason for which the model's intercept is usually greater than the risk-free return, and the slope lesser than that suggested by empirical observations (see also Fama, French 2004). The mismatch between theory and the real world is a source of practical consequences. The CAPM is used to estimate equity costs, and thus to appraise a company. Trying to estimate return using the classical model causes, however, that companies with a small beta are undervalued, while those with a large beta are overvalued (see Figure 2).

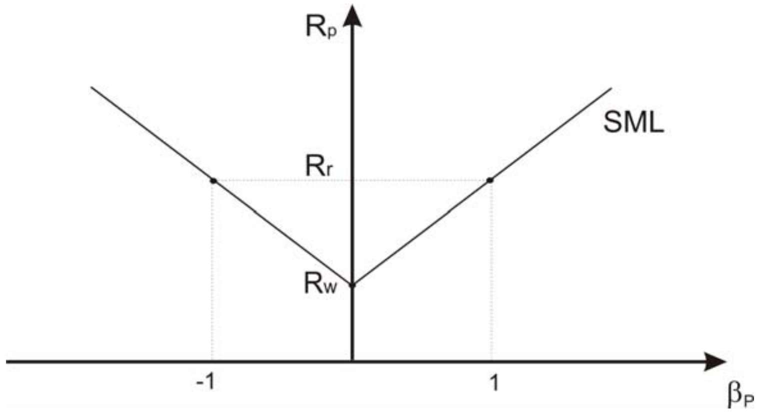

Fig. 2. V-shaped SML
Source: Cloninger et al. (2004) p.398.

Cloninger et al. researched years 1987-1995 in the US market. According to the formulated hypothesis that the SML is symmetric and V-shaped, the returns on securities with similar absolute values of the beta should be equal. The researchers divided all securities from that period into those having a positive beta and a negative beta. The number of the negative beta securities accounted for 5%-14% of all examined securities. The total numbers of securities in the sample ranged from 7004 in 1987 to 8789 in 1995. Time series of positive betas in each year were subjected to comparative analysis against analogous series of negative betas. The procedure provided the conclusion that most returns on the negative beta assets were either equal or greater than the corresponding returns of the positive beta assets. In two years only, i.e. 1988 and 1990, returns of the positive beta securities had statistically significantly higher betas than returns of the negative beta securities. It was demonstrated that the negative beta securities had returns that were positive and frequently greater than returns on the risk-free assets. As a consequence, the classical shape of the security market line was rejected.

At the later stage of the research, the regression analysis was applied to portfolios composed of 20 randomly picked assets; the portfolios were constructed while paying attention to include in them only assets with a predetermined sign of the beta coefficient. All portfolios, altogether 127 for each sample (with a negative beta and a positive beta), were subjected to regression analysis to estimate the empirical SML. The slope of the SML estimated using the negative beta coefficients was negative and statistically significant, with a statistically insignificant intercept representing the theoretical value of return on the risk-free assets. Its correspondent empirical SML estimated for a portfolio containing the positive beta securities had a statistically significant and positive slope and a statistically insignificant intercept. The significance test demonstrated the absence of statistically significant differences between the intercepts and the absolute slope value of both estimated SMLs. The conclusion was that the research confirmed the V-shaped graph of the SML, which contradicted the classical approach to the Capital Asset Pricing Model and the relationship between the systematic risk and portfolios' return that the model describes.

3. Research in the Polish market

In order to verify the results of research conducted by Cloninger et al. for the Polish circumstances the tests has been repeated, while introducing certain modifications. A research hypothesis was formulated that the SML is not a straight line, but takes a shape resembling the letter V. The hypothesis was followed by two series of tests. The first one employed t-statistics to compare returns offered by the positive and negative beta assets in successive half-yearly periods from 1999 to 2006. As for the other series, twenty investment portfolios were assembled for each half-yearly period, to which securities were allocated depending on their beta value and sign. Then the regression analysis was performed on average returns and beta coefficients of the portfolios in order to estimate the empirical SML and thus to validate its shape.

4. Data

To calculate returns used then to estimate the 12-month beta coefficients the Warsaw Stock Exchange data were employed. The data were quotations as of the last day of each month in the period 1999-2006. If for some reason a company was not quoted on that day, then the stock price quoted on that month's day closest to its last day was applied. Stock prices were adjusted for splits and when a rights issue took place, a stock was omitted from the analysis. The beta coefficients were calculated for all stocks quoted on Warsaw Stock Exchange for which the appropriate data were available. The return on 52-week treasure bills used in the research was found based on the Ministry of Finance data.

5. Methodology

Each stock's beta coefficient was calculated using monthly returns for the last twelve months during which a given stock was quoted. WIG index returns were assumed to combine the market portfolio. If a company was not quoted twelve times, then it was excluded from the analysis. Each portfolio's return was calculated as an average of half-yearly returns of all portfolio stocks.

At the next stage of the research, all companies were divided into twenty investment portfolios, with the beta coefficient being the criterion for allocating a company to a given portfolio. Ten portfolios were composed using positive beta stocks and another ten received stocks with a negative beta. Each time, the first portfolio contained stocks with the smallest absolute value of the beta and the last, i.e. the tenth portfolio, was made of companies with the highest absolute value of the beta coefficient. The portfolios were revalued on a half-yearly basis. According to Fama and French (1992), investors do not revalue their portfolios more often, also due to transaction costs. Because 320 investment portfolios were composed altogether using the systematic risk criterion, a given stock did not necessarily go to the same portfolio every time.

In order to verify the research hypothesis the t-statistics and regression analysis were employed. In the first place, returns of stocks with negative and positive beta coefficients were compared. The test was run twice, once for all stocks quoted at the Exchange and then only for paired stocks with equal absolute values of the beta coefficient. Stocks were paired assuming that coefficients within accuracy of 0.005 were equal.

Then the empirical SML was estimated for portfolios with a negative beta and a positive beta in order to answer the question, whether the intercept and the absolute slope value were equal to the return on treasure bills and the additional return.

The regression analysis was conducted using average beta coefficients and average returns calculated for all successive portfolios in the entire period of research. This procedure required the construction of ten portfolios with a positive beta and another ten with a negative beta. The regression equation is represented by formula (2).

$$R_P = \gamma_0 + \gamma_1 \beta_P + \xi_P \qquad (2)$$

where:

γ_0 – intercept,

γ_1 – slope coefficient,

ξ_P – random term.

To find the statistical significance with which the explanatory variables influence the explained variable two values were used in equation (2). Statistical significance of intercept

$\hat{\gamma}_0$ diminished by the average return on treasure bills in the analysed period was tested using t-statistics. The following hypotheses were formulated:

$$\text{H0: } \gamma_0 - \hat{\gamma}_0 = 0$$

$$\text{H1: } \gamma_0 - \hat{\gamma}_0 \neq 0$$

where:

$\hat{\gamma}_0 = R_W$,

R_W – return on Treasure Bills.

As for the slope coefficient, statistical significance of coefficient $\hat{\gamma}_1$ diminished by the real risk premium was investigated. The slope coefficient was expected to be equal to the real risk premium. Hence, the following hypotheses were put forward in testing expression $\hat{\gamma}_1 - \gamma_1$:

$$\text{H0: } \gamma_1 - \hat{\gamma}_1 = 0$$

$$\text{H1: } \gamma_1 - \hat{\gamma}_1 \neq 0$$

The real risk premium calculated using average real values from a given period was denoted as $\hat{\gamma}_1$. Formula $\hat{\gamma}_1 = R_R - R_W$ represents the applied method of calculation, where R_R is the return of the market portfolio and R_W is the return of a risk-free asset.

If alternative hypotheses were approved for both the analysed intercept and slope coefficient, then the empirical shape of the SML would deviate from its theoretical representation.

6. Research results

In order to compare returns on stocks with a negative beta and a positive beta, ranges of portfolios in successive years were examined. The comparative analysis employed t-statistics, with 0.95 taken as the confidence level. The results are presented in Table 1.

Table 1. Average beta coefficients and returns of all stocks quoted at the Warsaw Stock Exchange, years 1999-2006

Period		Average beta	Number of observations	Average return	t-statistics*
1999	1st half-year	-0.2580	11	0.0926	-1.472
		0.6942	145	0.2627	-1.165
	2nd half-year	-0.3285	17	0.1097	0.472
		0.8457	154	0.0808	0.495

2000	1st half-year	-0.2038	19	0.0847	-0.334
		0.8104	166	0.1157	-0.366
	2nd half-year	-0.4039	77	-0.0504	1.750
		0.8273	112	-0.1347	1.598
2001	1st half-year	-0.3677	37	-0.0155	3.663**
		0.7055	157	-0.2053	2.922**
	2nd half-year	-0.2960	49	-0.1664	-1.852
		0.8736	150	-0.0721	-1.778
2002	1st half-year	-0.4450	58	-0.1621	-1.348
		0.8352	149	-0.0921	-1.310
	2nd half-year	-0.5140	50	-0.1000	0.381
		0.9309	143	-0.1214	0.425
2003	1st half-year	-0.8490	31	0.0862	-1.515
		1.1105	149	0.2300	-1.401
	2nd half-year	-0.5692	16	0.7718	0.416
		1.2534	159	0.6711	0.309
2004	1st half-year	-0.7054	11	1.4838	3.422**
		1.3291	159	0.4794	1.109
	2nd half-year	-0.8530	26	0.2592	1.886
		2.2625	145	0.0706	2.013
2005	1st half-year	-0.4122	34	-0.1069	-1.902
		0.9471	141	0.0271	-2.668**
	2nd half-year	-0.4016	29	-0.0449	-1.915
		0.8415	169	0.4328	-3.855**
2006	1st half-year	-0.5998	23	0.4497	0.573
		0.9420	185	0.3617	0.722
	2nd half-year	-0.8684	16	0.7340	1.421
		0.9004	191	0.4613	1.158

* First value of t-statistics was calculated for equal variances, the other one assumed different variances.
** Returns for the negative and positive beta coefficients were statistically significantly different. The confidence level was 0.05.
Source: developed by the author.

A large majority of the results do not reveal a difference between the returns. Only in the first six months of 2001, a statistically significant difference was found. In the first half-year of 2004, t-statistics captured differences between the ranges of returns, when equal variances were assumed, and in the first and second half-yearly periods of 2005, t-statistics exposed differences for different variances.

Results for stocks with selected beta coefficients are similar. The stocks were matched so that the absolute values of the beta coefficients were equal. The research results are presented in Table 2.

Table 2. Average beta coefficients and returns of stocks with identical beta coefficients quoted at the Warsaw Stock Exchange between 1999 and 2006

Period		Average beta	Number of observations	Average return	t-statistics*
1999	1st half-year	-0.4762	3	-0.1808	-1.874
		0.4771	3	0.0587	-1.874
	2nd half-year	-0.3941	9	0.1007	0.382
		0.3949	9	0.0562	0.382

2000	1st half-year	-0.3056	9	0.0727	1.058
		0.2955	9	-0.0469	1.058
	2nd half-year	-0.3253	29	0.0682	2.027**
		0.3254	29	-0.1359	2.027**
2001	1st half-year	-0.3744	21	-0.0141	1.278
		0.3752	21	-0.1332	1.278
	2nd half-year	-0.3391	19	-0.2111	-2.185**
		0.3396	19	-0.0436	-2.185**
2002	1st half-year	-0.3409	28	-0.1473	-0.592
		0.3414	28	-0.0981	-0.592
	2nd half-year	-0.3859	28	-0.1484	-1.103
		0.3860	28	-0.0544	-1.103
2003	1st half-year	-0.4963	13	0.0908	-0.277
		-0.4963	13	0.1431	-0.277
	2nd half-year	-0.7494	8	1.2157	1.929
		0.7496	8	0.1359	1.929
2004	1st half-year	-0.4410	4	0.7778	0.555
		0.4433	4	0.2794	0.555
	2nd half-year	-0.7227	8	0.0725	1.204
		0.7176	8	-0.0980	1.204
2005	1st half-year	-0.4302	16	-0.0578	-0.117
		0.4306	16	-0.0485	-0.117
	2nd half-year	-0.5299	15	-0.1027	-2.567**
		0.5299	15	0.1754	-2.567**
2006	1st half-year	-0.5867	14	0.4920	0.419
		0.5864	14	0.3992	0.419
	2nd half-year	-0.6679	8	0.5672	0.759
		0.6674	8	0.3408	0.759

* First value of t-statistics was calculated for equal variances, the other one assumed different variances.
** Returns for negative and positive beta coefficients were statistically significantly different. The confidence level was 0.05.
Source: developed by the author.

Statistically significant differences between the ranges of returns were found in the second half-yearly periods of 2000, 2001, and 2005. In the other thirteen cases, the hypothesis about a difference between the ranges was disapproved.

It has been demonstrated so far that stocks with negative and positive beta coefficients offer similar levels of return, and that contrary to theory the negative beta stocks do not provide investors with lower returns. To analyze the SML shape ten portfolios with a negative beta and ten portfolios with a positive beta were constructed. The portfolios were created every six months, rearranging their composition to account for beta values of the portfolio stocks. Stocks with the lowest betas went to portfolio 1, and those with the highest beta to portfolio 10. If stocks could not be proportionally allocated to the portfolios, then additional, single stocks were added to portfolios with the highest beta coefficients. After average values of returns and beta coefficients for the time series of all portfolios were calculated, the regression analysis was performed, where the return of a successive portfolio was taken as the explained variable and portfolios' beta coefficients as the explanatory variable. The results of the analysis are presented in Table 3.

Table 3. Linear regression analysis of ten portfolios with a positive beta and ten portfolios with a negative beta (values of t-statistics are given in the parentheses)

	Negative beta coefficients	Positive beta coefficients
γ_0	0.020 (0.311)	0.088 (4.988)*
$\hat{\gamma}_0$	0.045	0.045
$\hat{\gamma}_0 - \gamma_0$	-0.025 (-0.375)	0.043 (2.419)*
γ_1	-0.035 (-4.335)*	0.072 (5.159)*
$\hat{\gamma}_1$	0.053	0.053
$\hat{\gamma}_1 - \gamma_1$	-0.404 (4.995)*	0.019 (-1.344)
R^2	0.701	0.769

* Statistically significant values for confidence level 0.95.
Source: developed by the author.

Figure 3 is the graphic representation of regression results that shows the empirical SML for portfolios with negative and positive betas. In both cases, the slope is statistically significant.

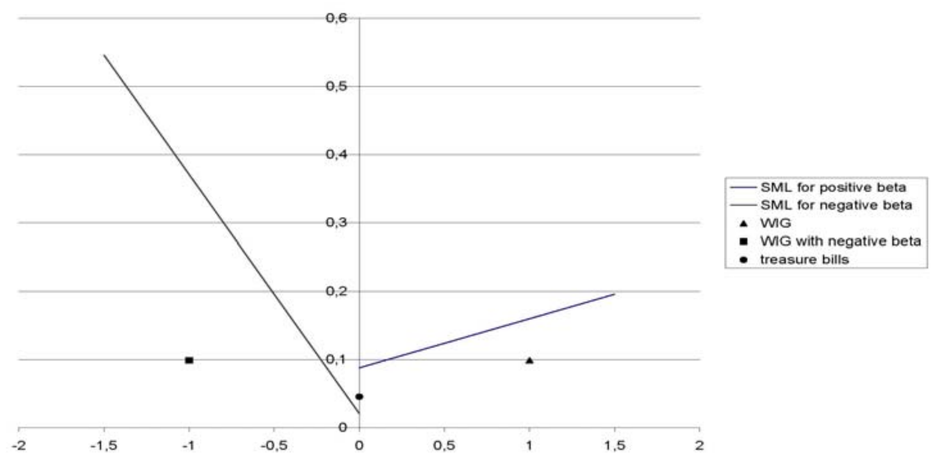

Fig. 3. The empirical SML for regression of separated negative and positive beta coefficients
Source: developed by the author.

For the negative beta portfolios, the slope is negative and, as expected, portfolio's return goes up with a falling beta coefficient. The alternative hypothesis failed to be approved for the intercept, which means that differences between the intercept value and the return on the risk-free assets could not be evinced. However, the alternative hypothesis was approved for the additional return, which means that the additional real return is statistically significantly different from the slope of the empirical SML.

Regarding the positive beta portfolios, the intercept is statistically significantly different from the return of the risk-free assets, but for the additional return the alternative hypothesis could not be approved; in other words, a statistically significant difference between the empirical return and the additional real return cannot be demonstrated.

As for the regression analysis applied to portfolios' returns and their correspondent absolute beta values, an effort was made to establish how the removal of the minus sign affects the Capital Asset Pricing Model. Regression results for the negative and positive beta portfolios suggest that the graph is not symmetric. A regression analysis using the absolute values of beta coefficients should therefore provide new results. All 20 portfolios were tested and the results of the procedure are presented in Table 4.

Table 4. Linear regression analysis of ten portfolios with a positive beta and ten portfolios with a negative beta (values of t-statistics are given in the parentheses)

	Absolute values of beta coefficients
$\hat{\gamma}_0$	0.074 (1.419)
γ_0	0.045
$\gamma_0 - \hat{\gamma}_0$	0.029 (0.557)
$\hat{\gamma}_1$	0.146 (2.963)*
γ_1	0.053
$\gamma_1 - \hat{\gamma}_1$	0.093 (1.885)
R^2	0.328

* Values are statistically significant for confidence level 0.95.
Source: developed by the author.

For the case of different intercept and return on the risk-free assets the alternative hypothesis was disapproved, which means a failure to find statistically significant evidence that the two values are different from each other. The situation of the empirical and additional real returns was similar.

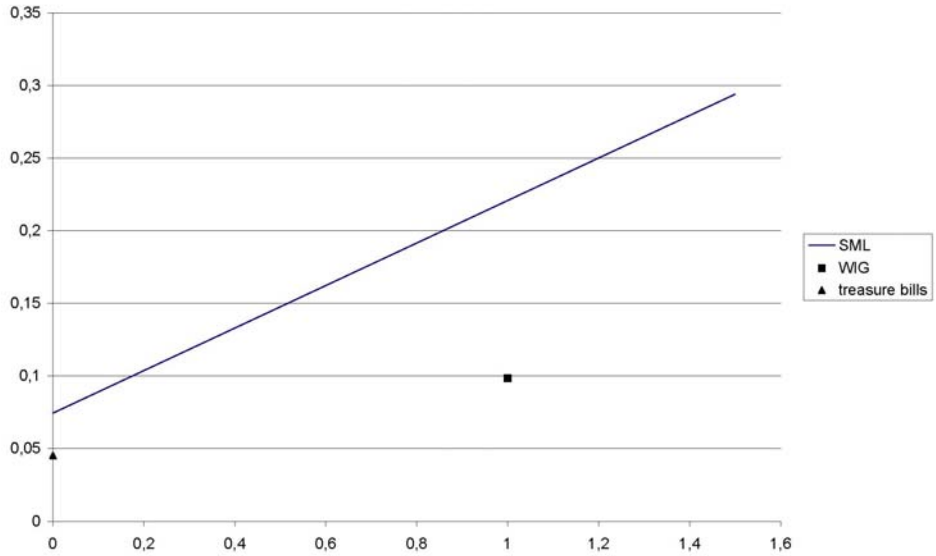

Fig. 4. The empirical SML estimated for absolute beta values
Source: developed by the author.

Conclusions

Statistical analysis was employed to demonstrate that the empirical SML has a V-like shape. By scrutinizing the ranges of returns for all quoted on Warsaw Stock Exchange companies year by year, a positive relationship between the returns and the absolute betas in the years 1999-2006 was found. With an increasing beta, the return on stocks would usually grow as well. The findings were confirmed by regression analysis applied to average returns and beta coefficients of twenty stock portfolios. As expected, the empirical SML showed the negative slope for the negative beta portfolios. Constructing portfolios from all available on the market share makes the research representative for whole market. Regression applied to portfolios for which the absolute beta value was found seems to validate the CAPM assumptions, according to which market equilibrium is influenced by the risk-free return, the return on the entire market and stock portfolio's systematic risk measured by the beta coefficient. Therefore, the research hypothesis stating that the empirical Security Market Line is V-shaped has been positively verified.

Notes

[1] Sharpe, Litner and Mossin are usually mentioned in the literature as CAPM authors; some sources, however, indicate also other researchers. See: French (2003), Zimmermann, Mertens (2002).

[2] Treynor's articles have never been published. It is believed, though, that he has made a substantial contribution to the theory development. In its works, he investigated the subject of market equilibrium, posing revolutionary theses. Even though Treynor's papers had circulated around the scientific world before Sharpe's publication did, he cannot be awarded the palm, since it is difficult to confirm objectively, whether he was really the first one to explore subjects connected with the Capital Assets Pricing Model.

[3] Black, Jensen, Scholes (1972), Sharpe, Cooper (1972), Fama, McBeth (1973), Banz (1981), Fama, French (1989).

References

Asgharian, H. & Hansson, B. (2005). A Critical Investigation of the Explanatory Role of Factor Mimicking Portfolios in Multifactor Asset Pricing Models. *Applied Financial Economics*, 15, pp.835-847.

Banz, R.W. (1981). The Relationship between Return and the Market Value of Common Stocks. *Journal of Financial Economics*, 9, pp. 3-18.

Black, F., Jensen, M.C. & Scholes, M. (1972). The Capital Asset Pricing Model: Some Empirical Tests. *Studies in the Theory of Capital Markets*, Praeger, pp. 79-124.

Blog, B., Van Der Hoek, G., Rinnooy Kan, A.H.G. & Timmer, G.T. (1983). The Optimal Selection of Small Portfolios. *Management Science*, 27(7), July, pp. 792-798.

Cloninger, D.O., Waller, E.R., Bendeck, Y. & Revere, L. (2004). Returns on negative beta securities: implications for the empirical SML. *Applied Financial Economics*, 14, Routledge, pp. 397-402.

Fama, E.F. & French, K.R. (1989). Business Conditions and Expected Returns on Stocks and Bonds. *Journal of Financial Economics*, 25, pp. 23-49.

Fama, E.F. & French, K.R. (1992). The Cross-section of the Expected Returns. *Journal of Finance*, 47, pp. 427-465.

Fama, E.F. & French, K.R. (2004). The Capital Asset Pricing Model: Theory and Evidence. Unpublished draft, January, p. 27.

Fama, E.F. & McBeth, J. (1973). Risk, Return and Equilibrium: Empirical Tests. *Journal of Political Economy*, 81(3), May-June, pp. 607-636.

Francis, J.C. (1986). *Investments: analysis and management*. New York: McGraw-Hill Inc., pp. 779-784.

French, C.W. (2003). The Treynor Capital Asset Pricing Model. *Journal of Investment Management*, 1(2), pp. 60-72.

Jensen, M.C. (1968). The Performance of Mutual Founds in the Period 1945-1964. *Journal of Finance*, May, pp. 389-417.

Litner, J. (1965). Security Prices, Risk and Maximal Gains from Diversification. *Journal of Finance*, December, pp. 587-615.

Mossin, J. (1966). Equilibrium of Capital Asset Market. *Econometrica*, October, pp. 768-783.

Sharpe, W. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Condition of Risk. *Journal of Finance*, September, pp.425-442.

Sharpe, W.F. & Cooper, G.M. (1972). Risk-Return Class of New York Stock Exchange Common Stocks 1931-1967. *Financial Analyst Journal*, March-April, pp.46-56.

Treynor, J. (1961). *Market Value, Time and Risk*. Unpublished paper.

Treynor, J. (1962). Toward a Theory of Market Value of Risky Assets. In R.A. Korajczyk (Ed.), *Asset Pricing and Portfolio Performance* (pp. 15-22). London: Risk Books 1999.

Zimmermann, H. & Mertens, E. (2002). *Capital Asset Pricing Model & Mutual Fund Performance Studies – Review and Evidence*. Wirtchaftswissenschaftliches Zentrum, WWZ, Universität Basel.