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*Adam Depta**

THE USE OF BLUME AND VASICEK METHODS IN THE ESTIMATION OF BETA COEFFICIENT IN THE SINGLE-INDEX MODEL

Abstract

This paper will present alternative methods of valuation of coefficients beta. The estimation of future coefficients beta can be received by delimitation the coefficients beta from past data and use these coefficients as the estimation of future coefficients beta. At the beginning we will present Blume method and in the second section Vasicek method.

Key words: coefficient beta in the single-index model, Blume method, Vasicek method.

I. INTRODUCTION

On the capital market the shares rate of return are determinated by the factor which reflects the changes on this market. The observation of prices of randomly chosen shares shows, that in the period of good economic situation at the exchange (measured with some of share indices) the majority of share prices grows, however when the condition of the market worsens, the prices of majority of shares fall. Empirical observations confirm that on many capital markets the shares rate of return are to a large extent related with rate of return of index market, which reflects the general situation on the market (Levy, 1971).

Let R_m it be the rate of return from the market index, a_i, β_i – the coefficients of equation, e_i – the random error term, then the rate of return from an i-th share R_i can be written with the help of the equation regress:

$$R_i = a_i + \beta_i R_m + e_i. \tag{1}$$

* Ph.D., student, Chair of Statistical Methods, University of Łódź.

This equation defines the linear dependence of return or rate share from rate of return the markets index. In practice the equation of regress is estimated and as a result the following model is received:

$$R_i = a_i + \beta_i R_m \tag{2}$$

which is security characteristic line. In this equation beta coefficient plays the basic part. It shows how many percent approximately will the rate of return share grow, when the rate of return from the market index grows by 1%. By estimation of security characteristic line it complies the data from past, which relate realized the rate of return shares and market index.

On the basis of ordinary least squares method the formula of parameter β_i is as follows:

$$\beta_i = \frac{\operatorname{cov}(R_i, R_M)}{\sigma_M^2} = \frac{\sum_{t=1}^{n} (R_{it} - \overline{R}_i)(R_{Mt} - \overline{R}_M)}{\sum_{t=1}^{n} (R_{Mt} - \overline{R}_M)^2} \tag{3}$$

where:

n – the number of periods of which information comes from,
R_{it} – the rate of return an i-th share in a t-th period,
R_{Mt} – the rate of return market index in a t-th period,
$\overline{R}_i$ – the arithmetical mean the rates of return from an i-th share,
$\overline{R}_M$ – the arithmetical mean the rates of return market index,
σ_M^2 – the variance of market index.

II. BLUME METHOD

Blume explored concerning of relate between the beta coefficients in next periods (Blume, 1971). He divided the period from July 1926 to June 1968 into seven-year-periods. Next, he calculated the beta coefficients by using to regress the monthly data. Then, he marked the beta coefficients for portfolios consisting of one share, to portfolios with fifty shares. As a result of these studies, he affirmed that the beta coefficients of large portfolios delivered considerable information about them the future beta coefficients. The reasons for differences among the beta coefficients with two different periods is firstly the fact, that the risk (the beta) can change the stock or portfolio, secondly the beta coefficient in every period be appointive with random error, and the greater this mistake is, then the less

accurate prognoses' of coefficients will be for future period. The changes of beta coefficient in portfolio take down mutually, in relationship from what it is observed the smaller hesitations of the real beta coefficients in case of portfolio than the individual shares. The mistakes of estimation the beta coefficients for individual stocks take down mutually, when it will join in portfolio these shares, therefore the mistake of estimation the portfolio coefficient will be lower. Let's notice that the beta coefficients of portfolios are laden with smaller mistake and change in smaller grade than the beta coefficients of individual shares, then the historical respects are more exact than in case of individual shares.

Blume method depends on it division observation on two parts I and II, and for each these parts with the help of ordinary least squares method it makes estimation the beta coefficients. In next stage, it takes place to regress the beta coefficient of second period in relation to the coefficient of the previous period:

$$\beta_{II,i} = a + b \times \beta_{I,i} + \varepsilon_i \tag{4}$$

Then, again with the help of ordinary least squares method for unknown parameters of regress the estimators $\hat{a}$ and $\hat{b}$ are received. Finally, modified the beta coefficient has the following aspect:

$$\beta_{Blume,i} = \hat{a} + \hat{b} \times \beta_{II,i} \tag{5}$$

The use of equation (5) leads to lowering of high values of beta coefficients, and the enlargement low.

In the aim of image this method marks the beta coefficients for the companies quoted on New York Stock Exchange in the support on monthly the rates of return in period July 1982 to June 1996. The share index Dow Jones Industrial Average was accepted as the explanatory variable the changes of rates of return shares. These audits were divided into two periods: July 1982 to June 1989 and July 1989 to June 1996. The results are presented in Table 1: it was not possible to conduct this audit on the Warsaw Stock Exchange because the quantity of observation was too small.

Table 1. The beta coefficients appointed with the use Blume method

No.	Name	Beta coefficients		Blume beta coefficients
		I period	II period	
1	3M Company	1.0118	0.8193	0.9109
2	Aetna, Inc.	0.7832	1.2464	1.0985
3	American Electric Power Company Inc.	0.4372	0.5068	0.7737
4	American Express Co.	1.4410	1.1206	1.0433

Table 1. (contd.)

No.	Name	Beta coefficients		Blume beta coefficients
		I period	II period	
5	Applera Corporation	1.3893	1.0955	1.0322
6	Avnet Inc.	1.3976	0.8014	0.9031
7	Bausch & Lomb Inc.	0.8037	1.0875	1.0287
8	Baxter International Inc.	1.0352	1.0341	1.0053
9	Boeing Corporation	1.2052	1.0693	1.0207
10	Boise Cascade Corporation	1.5295	1.1970	1.0768
11	Cigna Corp	0.8438	1.2189	1.0864
12	Cigna Investment Securities, Inc.	0.2485	0.2619	0.6661
13	Citigroup Inc.	0.9983	1.8291	1.3544
14	Colgate-Palmolive Co.	0.7998	0.9203	0.9553
15	Computer Sciences Corporation	1.2424	1.0357	1.0060
16	Consolidated Edison Inc.	0.2288	0.4621	0.7540
17	Corning Inc.	1.1365	0.6385	0.8315
18	CSX Corporation	1.3345	1.2467	1.0986
19	Dow Chemical Co.	1.2734	1.1425	1.0529
20	Dupont E I Nemours & Co.	1.2055	1.2006	1.0784
21	Eastman Kodak Co.	0.9302	0.5430	0.7896
22	Edison International	0.2916	0.3799	0.7179
23	Eli Lilly and Company	0.9432	1.0964	1.0326
24	Emerson Electric Co.	1.1533	1.0983	1.0334
25	Engelhard Corporation	1.0243	0.6918	0.8549
26	Exelon Corporation	0.3737	0.4825	0.7630
27	Fannie Mae	1.5136	1.4274	1.1780
28	Fleetwood Enterprises Inc.	1.4844	1.2076	1.0815
29	Ford Motor Company	1.3505	1.1268	1.0460
30	General Dynamics Corporation	1.0810	0.4036	0.7283
31	Goodyear Tire & Rubber Co.	1.3295	1.2940	1.1194
32	Hercules Incorporated	1.1763	0.9783	0.9807
33	Honeywell International, Inc.	0.8061	1.1216	1.0437
34	Humana Inc.	0.9487	1.4542	1.1898
35	International Business Machines Corporation	0.8293	0.8677	0.9322
36	International Flavors & Fragrances Inc.	0.9798	1.0333	1.0049
37	International Paper Co.	1.3278	1.2312	1.0918
38	Johnson & Johnson.	0.9168	1.0672	1.0198
39	Kroger Co.	0.5399	1.4330	1.1805
40	Mattel Inc.	1.4429	0.9846	0.9835
41	Mcdonalds Corporation	0.9612	1.0782	1.0246
42	Medtronic Inc.	0.8468	0.9320	0.9604
43	Merck & Co Inc.	0.7891	1.0643	1.0185
44	Motorola Inc.	1.5493	1.0187	0.9985
45	National Semiconductor Corporation	1.4816	1.2048	1.0802
46	Noble Energy, Inc.	1.0625	0.5314	0.7845
47	Norfolk Southern Corporation	1.1059	0.9591	0.9723
48	Nortel Network Corp.	1.3456	1.0255	1.0015
49	Northrop Grumman Corporation	0.7824	0.9235	0.9567

Table 1. (contd.)

No.	Name	Beta coefficients		Blume beta coefficients
		I period	II period	
50	Occidental Petroleum Corporation	0.7192	0.9895	0.9857
51	Pfizer Inc.	0.8654	1.2007	1.0784
52	Phelps Dodge Corporation.	1.4449	1.2104	1.0827
53	Pitney Bowes Inc.	1.3377	1.1970	1.0768
54	Procter & Gamble Co.	0.7840	1.0464	1.0107
55	Public Service Enterprise Group Inc.	0.3862	0.4603	0.7532
56	RadioShack Corporation	1.3168	1.2977	1.1210
57	Rockwell Automation, Inc.	1.1370	0.6407	0.8325
58	Royal Dutch Petroleum Company	0.5549	0.7415	0.8768
59	Ryder System, Inc.	1.3573	1.3505	1.1442
60	Sears Roebuck & Co	1.4491	1.2032	1.0795
61	Stewart Information Services Corp.	1.2673	1.0299	1.0034
62	StorageTek Corporation	1.6031	1.0681	1.0202
63	Tenneco Automotive Inc.	0.8095	1.1134	1.0401
64	Texas Industries	1.0938	1.0292	1.0031
65	Texas Instruments Inc.	1.3893	1.3144	1.1284
66	The Coca-Cola Company	0.6876	0.8903	0.9421
67	The Walt Disney Company	1.1601	1.2595	1.1043
68	United Auto Group Inc.	1.3799	0.9662	0.9755
69	Union Pacific Corporation	1.1926	0.9710	0.9775
70	UNISYS CORP	0.9777	1.9968	1.4280
71	United Technologies Corporation.	1.3953	1.2048	1.0802
72	Valero Energy Corporation	1.3523	0.7841	0.8955
73	Van Kampen Bond Fund	0.2261	0.3488	0.7043
74	Viacom Inc.	1.0843	1.0702	1.0211
75	Viad Corporation.	1.0659	0.9216	0.9558
76	Wachovia Corporation.	0.6905	1.0787	1.0249
77	Williams Companies Inc.	1.1622	0.8525	0.9255
78	Xerox Corporation	1.1853	1.0741	1.0228

Source: Own calculations.

III. VASICEK METHOD

On the ground the audits Blume (Blume, 1975) and Levy (Levy, 1971) of beta coefficient it noticed, that real value of beta coefficient in the period, when we make the prognosis, it is often closer the mean value of the beta coefficient, than the value estimated on the basis of the historical data. Vasicek proposed the technique, which relies on fitted the beta coefficient in dependence from grade of uncertainty the respect of the beta coefficient (Elton, Gruber, 1998). Vasicek procedure relies on calculation from historical the beta coefficient the weighted average for the share and the mean of the value beta coefficients in given sample shares of the past period where

the weights are added to the variance of distribution historical estimations the beta coefficient. These weights can be introduced as follows:

$$\text{for } \beta_{i1}\frac{\sigma_{\beta 1}^2}{\sigma_{\beta 1}^2+\sigma_{\beta 1}^2} \text{ and for } \overline{\beta}_1\frac{\sigma_{\beta i1}^2}{\sigma_{\beta 1}^2+\sigma_{\beta i1}^2}. \tag{6}$$

The prognosis of the beta coefficient for a share:

$$\beta_{i2}\frac{\sigma_{\beta i1}^2}{\sigma_{\beta 1}^2+\sigma_{\beta i1}^2}\overline{\beta}_1+\frac{\sigma_{\beta 1}^2}{\sigma_{\beta 1}^2+\sigma_{\beta 1}^2}\beta_{i1}. \tag{7}$$

where:

β_{i2} – the prognosis of the beta coefficient for an i-th share,

$\overline{\beta}_1$ – the average value of the beta coefficients beta in a given sample of shares from the past period,

β_{i1} – the beta coefficient from past for a given share,

$\sigma_{\beta 1}^2$ – the variance of distribution historical estimations of beta coefficient for given sample of shares,

$\sigma_{\beta i1}^2$ – the variance of distribution historical estimations of beta coefficient for given share.

Vasicek method using the weights corrects observations with large standard errors in larger grade than observations laden small standard errors. In this method the weight ascriptitious the beta coefficient of given share, in comparison to weight place on average the beta coefficient in sample, is inversely dependent from standard errors of the beta coefficient given share. With higher values of the beta coefficients of concrete shares, the higher standard errors are connected than in case of shares with lower the beta coefficients. Therefore for shares with higher coefficients, the beta coefficients will reduced in larger grade in relation to difference among their value and average value for sample, than will enlarged the beta coefficients for shares on low coefficients. From this it results that, the average assessment of future beta coefficient will be lower from average coefficient in sample of shares, on the ground which it takes place to estimation.

In the aim of image this method marks the beta coefficients for the companies quoted on New York Stock Exchange in the support on monthly the rates of return in period July 1982 to June 1996. The share index Dow Jones Industrial Average was accepted as the explanatory variable the changes of rates of return shares. These audits were divided into two periods: July 1982 to June 1989 and July 1989 to June 1996.

To every from periods with the help of ordinary least squares method it was estimated separately the beta coefficients for every with companies. Then on the ground the formula (7) it was marked the prognosis of the beta coefficient for an i-th share. The results are presented in Table 2.

Table 2. The beta coefficients appointed with the use Vasicek method

No.	Name	Beta coefficients		$\frac{\sigma^2_{\beta i1}}{\sigma^2_{\beta 1}+\sigma^2_{\beta i1}}\overline{\beta}_1$	$\frac{\sigma^2_{\beta 1}}{\sigma^2_{\beta 1}+\sigma^2_{\beta i1}}\beta_{i1}$	Vasicek beta coefficients
		I period	II period			
1	3M Company	1.0118	0.8193	0.0328	0.9802	1.0130
2	Aetna, Inc.	0.7832	1.2464	0.0325	0.7590	0.7915
3	American Electric Power Company Inc	0.4372	0.5068	0.0231	0.4276	0.4507
4	American Express Co.	1.4410	1.1206	0.0695	1.3455	1.4150
5	Applera Corporation	1.3893	1.0955	0.0954	1.2629	1.3583
6	Avnet Inc	1.3976	0.8014	0.0799	1.2912	1.3711
7	Bausch & Lomb Inc.	0.8037	1.0875	0.0462	0.7683	0.8145
8	Baxter International Inc.	1.0352	1.0341	0.0540	0.9819	1.0358
9	Boeing Corporation	1.2052	1.0693	0.0830	1.1098	1.1928
10	Boise Cascade Corporation	1.5295	1.1970	0.0781	1.4156	1.4937
11	Cigna Corp	0.8438	1.2189	0.0466	0.8063	0.8529
12	Cigna Investment Securities, Inc.	0.2485	0.2619	0.0122	0.2456	0.2578
13	Citigroup Inc.	0.9983	1.8291	0.0660	0.9355	1.0015
14	Colgate-Palmolive Co.	0.7998	0.9203	0.0332	0.7745	0.8076
15	Computer Sciences Corporation	1.2424	1.0357	0.0857	1.1408	1.2265
16	Consolidated Edison Inc.	0.2288	0.4621	0.0211	0.2242	0.2453
17	Corning Inc.	1.1365	0.6385	0.0588	1.0728	1.1316
18	CSX Corporation	1.3345	1.2467	0.0620	1.2556	1.3176
19	Dow Chemical Co.	1.2734	1.1425	0.0554	1.2061	1.2615
20	Dupont E I Nemours & Co.	1.2055	1.2006	0.0439	1.1551	1.1989
21	Eastman Kodak Co.	0.9302	0.5430	0.0407	0.8941	0.9348
22	Edison International	0.2916	0.3799	0.0216	0.2856	0.3072
23	Eli Lilly and Company	0.9432	1.0964	0.0443	0.9034	0.9477
24	Emerson Electric Co.	1.1533	1.0983	0.0418	1.1073	1.1491
25	Engelhard Corporation	1.0243	0.6918	0.0648	0.9610	1.0258
26	Exelon Corporation	0.3737	0.4825	0.0322	0.3622	0.3944

Table 2. (contd.)

No.	Name	Beta coefficients		$\frac{\sigma^2_{\beta i1}}{\sigma^2_{\beta 1}+\sigma^2_{\beta i1}}\overline{\beta}_1$	$\frac{\sigma^2_{\beta 1}}{\sigma^2_{\beta 1}+\sigma^2_{\beta 1}}\beta_{i1}$	Vasicek beta coefficients
		I period	II period			
27	Fannie Mae	1.5136	1.4274	0.1169	1.3448	1.4617
28	Fleetwood Enterprises Inc.	1.4844	1.2076	0.1051	1.3356	1.4407
29	Ford Motor Company	1.3505	1.1268	0.0690	1.2616	1.3306
30	General Dynamics Corporation	1.0810	0.4036	0.0535	1.0258	1.0793
31	Goodyear Tire & Rubber Co.	1.3295	1.2940	0.0821	1.2253	1.3075
32	Hercules Incorporated	1.1763	0.9783	0.0533	1.1165	1.1698
33	Honeywell International, Inc.	0.8061	1.1216	0.0457	0.7709	0.8167
34	Humana Inc.	0.9487	1.4542	0.0705	0.8849	0.9554
35	International Business Machines Corporation	0.8293	0.8677	0.0342	0.8023	0.8364
36	International Flavors & Fragrances Inc.	0.9798	1.0333	0.0504	0.9327	0.9831
37	International Paper Co.	1.3278	1.2312	0.0623	1.2489	1.3112
38	Johnson & Johnson.	0.9168	1.0672	0.0398	0.8821	0.9218
39	Kroger Co.	0.5399	1.4330	0.0715	0.5031	0.5746
40	Mattel Inc.	1.4429	0.9846	0.2058	1.1597	1.3655
41	Mcdonalds Corporation	0.9612	1.0782	0.0322	0.9316	0.9639
42	Medtronic Inc.	0.8468	0.9320	0.0687	0.7914	0.8600
43	Merck & Co Inc.	0.7891	1.0643	0.0317	0.7652	0.7970
44	Motorola Inc.	1.5493	1.0187	0.0917	1.4138	1.5055
45	National Semiconductor Corporation	1.4816	1.2048	0.1381	1.2864	1.4246
46	Noble Energy, Inc.	1.0625	0.5314	0.1008	0.9604	1.0611
47	Norfolk Southern Corporation	1.1059	0.9591	0.0414	1.0623	1.1037
48	Nortel Network Corp.	1.3456	1.0255	0.0770	1.2468	1.3238
49	Northrop Grumman Corporation	0.7824	0.9235	0.0774	0.7246	0.8020
50	Occidental Petroleum Corporation	0.7192	0.9895	0.0521	0.6835	0.7356
51	Pfizer Inc.	0.8654	1.2007	0.0430	0.8299	0.8729
52	Phelps Dodge Corporation.	1.4449	1.2104	0.1516	1.2360	1.3876
53	Pitney Bowes Inc.	1.3377	1.1970	0.0668	1.2525	1.3192
54	Procter & Gamble Co.	0.7840	1.0464	0.0291	0.7622	0.7913
55	Public Service Enterprise Group Inc.	0.3862	0.4603	0.0261	0.3766	0.4027
56	RadioShack Corporation	1.3168	1.2977	0.0967	1.1953	1.2920
57	Rockwell Automation, Inc.	1.1370	0.6407	0.0555	1.0768	1.1323
58	Royal Dutch Petroleum Company	0.5549	0.7415	0.0267	0.5407	0.5674
59	Ryder System, Inc.	1.3573	1.3505	0.0681	1.2691	1.3372
60	Sears Roebuck & Co	1.4491	1.2032	0.0634	1.3615	1.4249
61	Stewart Information Services Corp.	1.2673	1.0299	0.1023	1.1437	1.2459
62	StorageTek Corporation	1.6031	1.0681	0.2792	1.1763	1.4555
63	Tenneco Automotive Inc.	0.8095	1.1134	0.0342	0.7830	0.8173
64	Texas Industries	1.0938	1.0292	0.0768	1.0137	1.0905
65	Texas Instruments Inc.	1.3893	1.3144	0.1086	1.2455	1.3540
66	The Coca-Cola Company	0.6876	0.8903	0.0288	0.6687	0.6975
67	The Walt Disney Company	1.1601	1.2595	0.0859	1.0650	1.1510
68	United Auto Group Inc.	1.3799	0.9662	0.0870	1.2654	1.3524
69	Union Pacific Corporation	1.1926	0.9710	0.0526	1.1328	1.1854
70	UNISYS CORP	0.9777	1.9968	0.0570	0.9246	0.9816
71	United Technologies Corporation.	1.3953	1.2048	0.0615	1.3135	1.3750
72	Valero Energy Corporation	1.3523	0.7841	0.1886	1.1091	1.2977
73	Van Kampen Bond Fund	0.2261	0.3488	0.0119	0.2235	0.2354
74	Viacom Inc.	1.0843	1.0702	0.0968	0.9842	1.0810
75	Viad Corporation.	1.0659	0.9216	0.0655	0.9993	1.0648
76	Wachovia Corporation.	0.6905	1.0787	0.0775	0.6395	0.7169
77	Williams Companies Inc	1.1622	0.8525	0.0787	1.0750	1.1537
78	Xerox Corporation	1.1853	1.0741	0.0496	1.1292	1.1788

Source: Own calculations.

With the results contained in Table 2 it is possible to notice that if the beta coefficient estimated on the basis of historical data is higher than 1, then the corrected the same beta coefficient with the help of Vasicek method is smaller than the one which was estimated on the ground of historical data. In case, when estimated on the ground of historical data the beta coefficient is smaller than 1, then the corrected it will be higher from him.

IV. CONCLUSIONS

In the literature on the subject there is widespread discussion related to the usefulness the presented methods for estimation of the beta coefficients. Estimations of these coefficients can be applied in construction of investment portfolios which can protect from risk with the help of future contracts. The use of introduced methods can arouse some doubt particularly in case of developing markets, where large influence on stock prices is exerted by behaviour of small investors. Decisions undertaken there by investors cause that the price of quoted stocks can change considerably, sometimes from session to session. We should also underline the fact that except choice of method estimation of beta coefficient, we should analyse the influence of the value of this coefficient on the choice of market portfolio as level of reference of studied period and compartment temporary between observations.

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Adam Depta

ZASTOSOWANIE METOD BLUME'A ORAZ VASICKA W SZACOWANIU WSPÓŁCZYNNIKA BETA W MODELU JEDNOWSKAŹNIKOWYM

Streszczenie

Na rynku kapitałowym kształtowanie się stóp zwrotu akcji jest zdeterminowane działaniem czynnika odzwierciedlającego zmiany na tym rynku. Obserwacja cen losowo wybranych akcji pokazuje, że w czasie dobrej koniunktury na giełdzie (mierzonej którymś z indeksów giełdowych) większość cen akcji rośnie, natomiast kiedy sytuacja na rynku się pogarsza, ceny większości akcji spadają. Obserwacje empiryczne potwierdzają, że na wielu rynkach kapitałowych stopy zwrotu większości akcji są w dużym stopniu powiązane ze stopą zwrotu z indeksu rynku, odzwierciedlającego ogólną sytuację na rynku.

Celem artykułu jest przedstawienie alternatywnych metod szacowania współczynników beta. Oszacowanie przyszłych współczynników beta można otrzymać przez wyznaczenie współczynników beta dla danych z przeszłości i wykorzystanie tych współczynników jako szacunków przyszłych współczynników beta. Przedstawione zostały dwie metody szacowania współczynnika beta: Blume'a oraz Vasicka.