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ARE BETA PARAMETERS STABLE ON THE WARSAW STOCK EXCHANGE?

Introduction

In highly developed economies, particularly intensive research referring to beta parameter was carried out. The following features of the beta parameter were tested: for example its stability, mainly in the context of the exchange cycle phases (bull and bear market) and the prognostic strength (for example Blume¹ and Levy²). Fabozzi and Francis³ believe that there is no need to estimate beta parameters for the upward and downward market cycles separately. The results of Kim and Zumwalt's⁴ analyses deny these conclusions; they have found that beta parameters estimated separately for the upward and downward market cycles have greater prognostic strength. Other authors, for example Eubank and Zumwalt⁵; Chen⁶; Alexander and Benson⁷; Fisher and Kamin⁸;

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¹ M.E. Blume, *On the Assessment of Risk*, "Journal of Finance" 1971, Vol. 26, No. 1, pp. 1–10.

² R.A. Levy, *Beta Coefficient as Predictors of Return*, "Financial Analysts Journal" 1974, Vol. 30, No. 1, pp. 61–69.

³ F.F. Fabozzi, J. C. Francis., *Stability Tests for Alphas and Betas over Bull and Bear Market Conditions*, "The Journal of Finance" 1977, Vol. 32, No. 2, pp. 1093–1099.

⁴ M. Kim, K. Zumwalt, *An Analysis of Risk in Bull and Bear Markets*, "Journal of Financial and Quantitative Analysis" 1979, Vol. 14, No. 5, pp. 1015–1025.

⁵ A.A. Eubank, J.K. Zumwalt, *An Analysis of the Forecast Error Impact of Alternative Beta Adjustment Techniques and Risk Classes*, "The Journal of Finance" 1979, Vol. 34, No. 3, pp. 1015–1025.

⁶ S. Chen, *An Examination of Risk-Return Relationship in Bull and Bear Markets Using Time-Varying Betas*, "Journal of Financial and Quantitative Analysis" 1982, Vol. 17, No. 2, pp. 265–286.

⁷ G.J. Alexander, P.G. Benson, *More on Beta as a Random Coefficient*, "Journal of Financial and Quantitative Analysis" 1982, Vol. 17, No. 1, pp. 27–36.

⁸ L. Fisher, J.H. Kamin, *Forecasting Systematic Risk: Estimates of "Raw" Beta that Take Account of the Tendency of Beta to Change and the Heteroskedasticity of Residual Returns*, "Journal of Financial and Quantitative Analysis" 1985, Vol. 20, No. 2, pp. 127–149.

Brennan and Copeland⁹; Lin and Chen¹⁰; Clarkson and Thompson¹¹; Sercu et al.¹²; Berger¹³; either confirmed the above conclusion or contradicted it.

There are also plenty of papers published just after 2000, containing studies about the stability of the beta parameter for developing or post-transition economies. A relatively large number of such studies refers to the Indian and Polish economy. One can quote here international papers by Bhaduri and Durai¹⁴, Ray¹⁵, Sing¹⁶, Deb and Misra¹⁷ and some studies by Polish authors, for instance by Feder-Sempach,¹⁸ Brzeszczyński et al.¹⁹, Dębski and Feder-Sempach²⁰, Dębski et al.²¹, and also papers by: Cwynar²²; Witkowska²³; Tarczyński²⁴; Kurach²⁵.

⁹ M.J. Brennan, T.E. Copeland, *Beta Changes around Stock Splits: A Note*, "Journal of Finance" 1988, Vol. 43, No. 4, pp. 1009–1013.

¹⁰ W.T. Lin., Y.H. Chen, *Investment Horizon and Beta Coefficient*, "Journal of Business Research" 1990, Vol. 21, No. 1, pp. 19–37.

¹¹ P.M. Clarkson, R. Thompson, *Empirical Estimates of Beta When Investors Face Estimation Risk*, "Journal of Finance" 1990, Vol. 45, No. 2, pp. 431–453.

¹² P. Sercu, M. Vanderbroek, T. Vinaimon, *Thin-Trading Effects in Beta: Bias v. Estimation Error*, "Journal of Business Finance and Accounting" 2008, Vol. 35, No. 9/10, pp. 1196–1219.

¹³ D. Berger, *Financial Turbulence and Beta Estimation*, "Applied Financial Economics" 2013, Vol. 23, No. 3, pp. 251–263.

¹⁴ S. Bhaduri, S. Durai, *Asymmetric beta in bull and bear market conditions: evidence from India*, "Applied Financial Economics Letters" 2006, No. 2, pp. 55–59.

¹⁵ K.K. Ray, *Stability of Beta over Market Phases: An Empirical Study on Indian Stock Market*, "International Research Journal of Finance and Economics" 2010, No. 50, pp. 174–189.

¹⁶ R. Singh, *Beta Stationarity over Bull and Bear Markets In India*, "The ICAFI Journal of Applied Finance" 2008, Vol. 14, No. 4, pp. 32–47.

¹⁷ S.G. Deb, S. Misra, *Are Equity Betas Stable? Evidence from Indian Equity Market*, "The IUP Journal of Applied Finance" 2011, Vol. 17, No. 4, pp. 5–25.

¹⁸ E. Feder-Sempach, *Ryzyko inwestycyjne. Analiza polskiego rynku akcji (The investment risk. Analysis of the Polish stock market)*, CeDeWu.pl Wydawnictwa Fachowe, Warszawa 2011.

¹⁹ J. Brzeszczyński, J. Gajdka, T. Schabek, *The Role of Stock Size and Trading Intensity in the Magnitude of the „Interval Effect” in Beta Estimation: Empirical Evidence from the Polish Capital Market*, "Emerging Markets Finance & Trade" 2011, Vol. 47, No. 1, pp. 28–49.

²⁰ W. Dębski, E. Feder-Sempach, *Beta Coefficients of Polish Blue Chip Companies in the Period of 2005–2011*, „Folia Oeconomica Stetinesia”, No. 2, 2012, pp. 90–102.

²¹ W. Dębski, E. Feder-Sempach, B. Świdorski, *Stabilność parametru beta w okresie rynku byka i niedźwiedzia dla największych spółek warszawskiej GPW (The stability of beta parameters in the period of the bull and bear market for the largest companies in the Warsaw Stock Exchange)*, „Zarządzanie i Finanse” 2013, Vol. 11, No. 2, pp. 89–102.

²² W. Cwynar, *Personalizacja w pomiarze ryzyka rynkowego (Personalisation in the measurement of market risk)*, „e-Finanse – Finansowy Kwartalnik Internetowy” 2008, Vol. 8, pp. 1–10.

²³ D. Witkowska, *Badanie stabilności współczynnika beta oszacowanego na podstawie prób o różnej długości (Examination of the stability of the beta parameter estimated from tests of different lengths)*, „Rynek Kapitałowy, Skuteczne Inwestowanie”, Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania No. 9, Uniwersytet Szczeciński, Szczecin 2008, pp. 143–154.

²⁴ W. Tarczyński, *O pewnym sposobie wyznaczania współczynnika beta na polskim rynku kapitałowym (About a method of determining the beta coefficient on the Polish capital market)*, „Zeszyty Naukowe”, Uniwersytet Szczeciński, No. 561, Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania, Szczecin 2009, pp. 199–214.

²⁵ J. Kurach, *Does Beta Explain Global Equity Market Volatility – Some Empirical Evidence*, "Contemporary Economics" 2013, Vol. 7, No. 2, pp. 55–66.

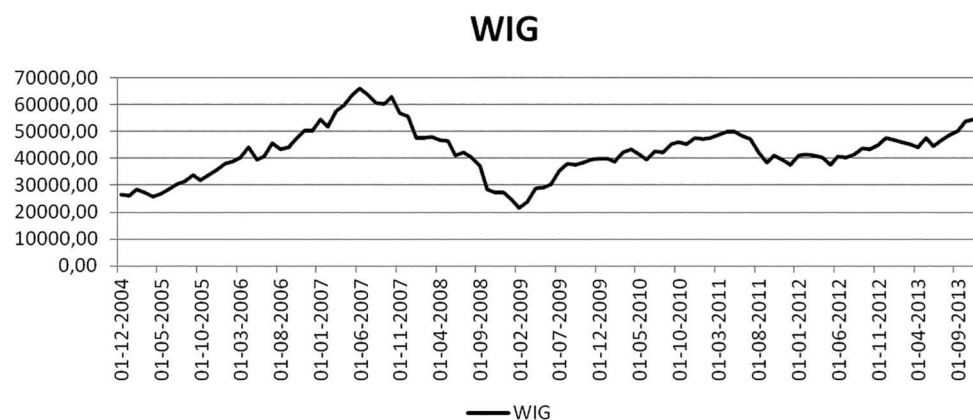
The goal of this article is to investigate the stability of the beta parameter for the 134 largest companies listed on the Warsaw Stock Exchange. The study was conducted for monthly rates of return in the period between 2005 and 2013, broken down into periods of growth (bull market) and decline (bear market). The hypothesis which will be verified is that the parameters of beta are stable. Beta parameters are estimated using the ordinary least squares method with the use of Sharpe's single-index model.

1. Methodology of the conducted study

For the study, monthly logarithmic rates of return (108 observations for each company) were adopted, calculated on the basis of closing prices on the last trading day of the month (excluding dividend income). Then, the tested period was divided according to the following two definitions (DEF1 and DEF2):

1. DEF1 – the basic period of the Warsaw Stock Exchange Index (WIG) from the bottom (the lowest value of the index) to the top (the highest value of the index) is a bull market and the period from the top to the bottom is a bear market. The chart of the WIG index is shown below.
2. DEF2 – the period in which the rate of return of the WIG index is greater in the month t than the rate of return in the month $t-1$, is a period of the bull market and period in which the rate of return of the WIG index in the month t is less than the rate of return in the month $t-1$, is the period of the bear market.

Figure 1. Chart of the WIG index between 2005 and 2013



To estimate the beta parameters of the surveyed companies on the bull and bear market, Beta Dual Market Model (DBMM)²⁶ was used in the following form:

$$R_{it} = \alpha_i + \beta_{iH} D_1 R_{WIG,t} + \beta_{iB} D_2 R_{WIG,t} + \varepsilon_{it} \quad (1)$$

where:

$R_{WIG,t}$ – rate of return of the WIG index in the month t,

$D_1 = 1$ for the bull market and 0 for the bear market,

$D_2 = 0$ for the bull market and 1 for the bear market,

α_i – intercept of the i-th stock,

β_{iH} – beta parameter for the bull market of the i-th share,

β_{iB} – beta parameter for the bear market of the i-th share,

ε_{it} – random term of the i-th stock in the month t.

This model is derived from Sharpe's single-index model, which has the form:

$$R_{it} = \alpha_i + \beta_i R_{WIG,t} + \varepsilon_{it} \quad (2)$$

where β_i is the beta parameter measuring the impact of the rate of return of the stock exchange index on the rate of return of the i-th share also interpreted as the ratio of the sensitivity of the rate of return of shares on changes of the rate of return of the stock exchange index.

2. Discussion on the obtained results

The results of examination of the stability of beta parameters in the period of the bull and bear market for the largest companies in the Warsaw Stock Exchange in the form of the rate of rejection of applied tests are summarised in Table 1.

Table 1. Fractions of rejections of verified hypotheses for surveyed shares of companies

	DEF1			DEF2		
	pval ≤ 0.01	pval ≤ 0.05	pval ≤ 0.1	pval ≤ 0.01	pval ≤ 0.05	pval ≤ 0.1
pChow	0.0448	0.1343	0.1940	0.0299	0.1045	0.1567
p0	0.0075	0.0299	0.0672	0.0000	0.0373	0.0672

²⁶ S. Bhaduri, S. Durai, op.cit.

	DEF1			DEF2		
	pval \leq 0.01	pval \leq 0.05	pval \leq 0.1	pval \leq 0.01	pval \leq 0.05	pval \leq 0.1
pval β_{iH}	0.5075	0.6940	0.7687	0.2313	0.3881	0.5075
pval β_{iB}	0.5299	0.6791	0.7388	0.2761	0.4478	0.5000
pval b1	0.1493	0.2910	0.4030	0.1418	0.2313	0.3582
pval b2	0.2239	0.3358	0.4030	0.1567	0.2313	0.3060

Source: Own calculations.

Explanatory notes:

1. pChow – estimated level of significance in the Chow stability test (H0: beta during the bull market is equal to the beta during the bear market).
2. p0 – estimated level of significance in the Kolmogorov-Smirnov test (H0: distributions of the rests in the model (2) are the same during the bull market and bear market).
3. pval β_{iH} – estimated level of significance in the test, where H0: estimation of β_i parameter in the model (3) during the bull market is equal to the value of the same ratio (treated as constant) during the bear market.
4. pval β_{iB} – estimated level of significance in the test, where H0: estimation of β_i parameter in the model (3) during the bear market is equal to the value of the same ratio (treated as constant) during the bull market.
5. pval b1 – estimated level of significance in the bootstrap test 1.
6. pval b2 – estimated level of significance in the bootstrap test 2.

The study was conducted using four methods.

1. In the first one, the stability of beta parameters was checked with the Chow test (the row pChow). The results indicate that for the vast majority of the analysed companies there is no reason to reject the hypothesis of equality of beta parameter in the period of the bull market and bear market. For example, at the level of significance of 0.05 for only 13.4% of the companies according to DEF1 and 10.4% of companies according to DEF2, H0 should be rejected but in the remaining 86.6% and 89.6% of the companies respectively there are no grounds for its rejection.
2. In the second method, the stability of beta parameters was examined with the Kolmogorov-Smirnov test (the row p0). The results show that only for a small number of the analysed companies the p-values for this test are low. For example, at the level of significance of 0.1, neither DEF1 or DEF2 values of rejection fraction for this test exceed 6.7% of companies. The results obtained confirm the results of the study presented in Dębski et al.²⁷.

²⁷ W. Dębski, E. Feder-Sempach, B. Świdorski, op.cit.

3. In the next method, the stability of beta parameters during the bull market and bear market was verified on the basis of t-student statistics²⁸. The frequencies of estimates of this statistic for three levels of significance are presented in rows $pval_{\beta iH}$ and $pval_{\beta iB}$. They show that depending on the period of bull market or bear market adopted in DEF1 in more than half of the companies (69.4% exactly in the first case and 67.9% in the second case, for the level of significance of 0.05), there are no grounds to reject H_0 , which implies that in most cases there are no grounds to reject the hypothesis of equality of these parameters. For the remaining number of companies, that is respectively 30.6% and 32.1% at a significance level of 0.05, these parameters are not stable. According to the second definition (DEF2), the beta parameters are stable in the periods of the bull market and bear market for a smaller number of companies (in other words there is no reason to reject the hypothesis of their stability), namely for 38.8% and 44.8% respectively. It also means that, according to this test and the definition of the bull and the bear market, in about 60% of companies beta parameters in these periods are not stable.
 4. In the fourth method, the examination of stability of beta parameters during the bull market and bear market was based on the bootstrap procedure. 10,000 simulations were carried out to check whether these parameters in these subperiods had the same distributions. Two bootstrap tests were used²⁹. The frequencies for both tests are presented in rows $pval_{b1}$ and $pval_{b2}$. The results indicate that at the level of significance of 0.05, according to DEF1, the hypothesis of stability of the beta parameters during the bull and the bear market should be rejected for about 30% of companies, and according to DEF2 – for 23.1% of the companies.
- In conclusion, the four methods used to study stability provided grounds for similar conclusions. First of all, they did not allow for an unambiguous statement that beta parameters in the period of bull market and bear market for 134 surveyed companies of the Warsaw Stock Exchange are stable or unstable. In general, it has been confirmed that for more than a half of the companies (with some of the tests, it is even more than 70% of companies) these parameters are stable.

²⁸ G.S. Maddala, *Ekonometria (Econometrics)*, trans. M. Gruszczyński, E. Tomczyk, B. Witkowski, Wyd. Naukowe PWN, Warszawa 2008, p. 116.

²⁹ E. Bradley, R.J. Tibshirani, *An Introduction to the Bootstrap*, Chapman and Hall, New York 1993.

3. Summary

The four methods used for examining the beta stability have not produced a clear answer to the question whether these parameters are stable or not. In general, for more than a half of the investigated companies (i.e. 60–70%, depending on the method used) beta parameters have proved to be stable. This means that for 30–40% of the analysed companies these parameters in the period of the bull and bear market differ from the statistical point of view. It also means that there is a need for further research in this field, for example, carried out on a larger sample or divided into large, medium and small companies.

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Are Beta Parameters Stable on the Warsaw Stock Exchange?

Beta parameter is one of the commonly used measurements of individual stock or portfolio investment risk and plays a crucial role in modern portfolio theory particularly in management of financial investment portfolios. Many studies have been done in this field, particularly on its properties such as stability in the context of the stock market cycle phases, measuring frequency of rate of return, length of sample period. However, the number of studies concerning beta parameter in the counties of Central and Eastern Europe that have undergone systemic transformation at the end of the previous century is much lower. Therefore we decided to study the changes of behavior of the beta parameter in those countries. The main aim of this article is to examine the beta parameter stability over bull and bear market conditions on the Warsaw Stock Exchange. The paper presents an analysis of betas stability for 134 stocks of the largest companies listed at the WSE during years 2005–2013.

Key words: beta parameter, Sharpe's single – index model, bull and bear market, stability of beta, Warsaw Stock Exchange

Les paramètres bêta sont-ils stables sur la Bourse de Varsovie?

Le paramètre bêta est l'une des mesures couramment utilisées des actions individuelles ou d'un risque d'un portefeuille d'investissement. Il joue un rôle crucial dans la théorie moderne du portefeuille, notamment dans la gestion de portefeuille d'investissement. De nombreuses études ont été réalisées dans ce domaine, en particulier sur la stabilité dans le contexte des phases du cycle du marché boursier et sur la mesure de la fréquence de taux de rendement. Cependant, le nombre d'études concernant le paramètre bêta dans les états de l'Europe centrale et orientale, qui ont subi une transformation systémique à la fin du 20ème siècle, est beaucoup plus faible. Par conséquent, nous avons décidé d'étudier le paramètre bêta dans ces pays. L'objectif principal de cet article est d'examiner la stabilité du paramètre bêta dans des conditions du marché haussier et baissier sur la Bourse de Varsovie. Le document présente une analyse des actions de 134 des plus grandes sociétés cotées à la Bourse de Varsovie au cours des années 2005–2013.

Mots clés: le paramètre bêta, le ratio de Sharpe, le marché haussier et baissier, la stabilité du bêta, la Bourse de Varsovie

Являются ли бета-коэффициенты на Варшавской фондовой бирже стабильными?

Бета-коэффициент широко используется для измерения рисков инвестирования в акции или инвестиционный портфель. Он играет ключевую роль в современной теории портфеля, особенно в управлении портфелем финансовых инвестиций. Проведено много исследований, которые в основном относятся к его свойствам, таким как стабильность в контексте стадий фондового рынка, связанных с его циклом, в зависимости от частоты измерения доходности или длины периода выборки. Однако, значительно меньше исследований, касающихся бета-коэффициента в странах Центральной и Восточной Европы, прошедших системную трансформацию в конце прошлого века. Поэтому авторы решили изучить изменения бета-коэффициента в этих странах. Основная цель этой статьи заключается в изучении стабильности бета-коэффициента во время бычьего и медвежьего рынков на Варшавской фондовой бирже. Статья содержит анализ стабильности бета-коэффициента акций 134 крупнейших компаний, котирующихся на Варшавской фондовой бирже в период 2005–2013 гг.

Ключевые слова: бета-коэффициент, одноиндексная модель Шарпа, бычий и медвежий рынки, Варшавская фондовая биржа