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Correlation between profitability and accounting betas for the Polish construction sector

1. Introduction

In the previous research, it was found that there are significant similarities between market betas and accounting betas, for both food and construction companies listed on the Warsaw Stock Exchange. The correlation was positive and stronger for the downside risk approach than the mean-variance approach.[2] In those works, the concept of downside accounting betas was proposed as a new idea. The average rate of return on the capital market was not considered.

In this paper it is examined if accounting betas have an impact on the average rate of return on the capital market. We analyse the systematic risk in the downside and variance approach. The data of the Polish construction sector were used in this case.

Accounting beta was first proposed by Hill and Stone[3] and is similar to market beta. It is assumed that accounting returns are generated by a stochastic process which is structurally like generating stock market returns. Accounting beta can be used as an additional tool for calculating the systematic risk of companies listed on the capital market. Accounting beta can also be calculated for non-listed companies to estimate their risk, instead of market beta.[4] Market

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[2] A. Rutkowska-Ziarko, C. Pyke, *The development of downside accounting beta as a measure of risk*, "Economics and Business Review" 2017, vol. 4, pp. 55–65.
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[3] N. Hill, B. Stone, *Accounting Betas, Systematic Operating Risk, and Financial Leverage: A Risk-Composition Approach to the Determinants of Systematic Risk*, "The Journal of Financial and Quantitative Analysis" 1980, vol. 15(3), pp. 595–637.

[4] J. Sarmiento-Sabogal, M. Sadeghi, *Estimating the cost of equity for private firms using accounting fundamentals*, "Applied Economics" 2015, vol.47(3), pp. 288–301.

betas measure the sensitivity of the return from the shares of a given company which are caused by changes in the return of the market portfolio (or market indexes), whereas accounting betas measure the sensitivity of the profitability ratio of a given company caused by changes in the profitability of the whole sector.

The aim of this paper is to examine whether accounting betas and downside accounting betas have an impact on the average rate of return on the capital market.

2. Methodology and data

2.1. Downside Accounting Beta

The classical measure of systematic risk are the beta coefficients (β_i) used in Sharpe's CAPM model, which are usually calculated as follows:

$$\beta_i = \frac{COV_{iM}}{S_M^2}, \tag{1}$$

where:
COV_{iM} – covariance of the rate of return for stock i and market portfolio rates of return,
S_M^2 – variance of market portfolio rates of return.

In this approach, it is assumed that investors display mean-variance behaviour.[5] If investors treat risk as the possibility of losing, or not earning enough, compared to a given target point, then the appropriate measure of systematic risk should be downside beta (β_i^{LPM}), calculated as follows):[6]

$$\beta_i^{LPM} = \frac{CLPM_i^2}{dS_M^2(f)}, \tag{2}$$

where:
$CLPM_i^2$ – asymmetric mixed lower partial moment of the second degree for stock exchange listed company i,

[5] J. Estrada, *Systematic risk in emerging markets: The D–CAPM*, "Emerging Markets Review" 2002, vol. 3, pp. 365–379.

[6] K. Price, B. Price, T.J. Nantell, *Variance and lower partial moment measures of systematic risk: some analytical and empirical results*, "The Journal of Finance" 1982, vol. 37(3), pp. 843–855.

$dS_M^2(f)$ – semi-variance of the market portfolio determined in relation to the risk-free rate of return.

In this paper, it is assumed that when determining both semi-variance and the lower partial moment, that the reference point is the risk-free rate (R_{ft}) when changing its value from one period to another. The asymmetric mixed lower partial second-degree moment is an analogue of covariance in the downside approach.

The asymmetric mixed lower partial moment of the second degree is calculated as follows:[7]

$$CLPM_i^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left(R_{it} - R_{ft}\right) * lpm_{Mt}, \tag{3}$$

where:

$$lpm_{Mt} = \begin{cases} 0 \quad for \quad R_{Mt} \geq R_{ft} \\ R_{Mt} - R_{ft} \; for \quad R_{Mt} < R_{ft} \end{cases},$$

R_{it} – the rate of return on security i at time t,
R_{Mt} – market portfolio rate of return in the period t. In a similar way, the semi-variance of the market portfolio is calculated:

$$dS_M^2(f) = \frac{\sum_{t=1}^{T} lpm_{Mt}^2}{T-1}. \tag{4}$$

In determining the downside beta coefficients, those periods in which the market rate of return is higher than the risk-free rate of return are disregarded. Both kinds of betas could be regarded as the "market beta", since the market rate of return is used to calculate the systematic risk.

To calculate accounting beta, one of the profitability ratios can be used instead of the market rate of return. The accounting beta coefficient for Return on Assets ($\beta_i(ROA)$) could be calculated as follows:[8]

$$\beta_i(ROA) = \frac{COV_{iM}(ROA)}{S_M^2(ROA)}, \tag{5}$$

[7] K. Price, B. Price, T.J. Nantell, *Variance and lower partial moment measures of systematic risk: some analytical and empirical results*, "The Journal of Finance" 1982, vol. 37(3), pp. 843–855.

[8] N. Hill, B. Stone, *Accounting Betas, Systematic Operating Risk, and Financial Leverage: A Risk-Composition Approach to the Determinants of Systematic Risk*, "The Journal of Financial and Quantitative Analysis" 1980, vol. 15(3), pp. 595–637.

$COV_{iM}(ROA)$ – covariance of the profitability ratio of company i and market portfolio ratios (market indices of profitability ratios),
$S_M^2(ROA)$ – variance of market profitability ratios.

In this way, we can calculate the accounting beta for different profitability ratios such as Return on Assets (ROA), Return on Equity (ROE), Return on Sales (ROS), as well for other accounting ratios.

One of the problems with applying the concept of downside market beta to accounting beta is the target level of a given ratio. To calculate market beta, the risk-free rate is used, although there is not anything similar for accounting ratios, which is one of the limitations of the proposed methodology. One solution is to use the average level of a financial ratio in each sector as the target point. The same approach has been proposed for calculating the semi-variance of profitability ratios by Rutkowska-Ziarko (2015).[9]

The methodology from our previous work is used to calculate downside accounting beta [10]. Let us try to define the downside accounting beta for ROA:

$$\beta_i^{LPM}(ROA) = \frac{CLPM_i^2(ROA)}{dS_M^2\left(\overline{ROA}_M\right)} \tag{6}$$

where:
$\overline{ROA}_M$ – average level of ROA for all analysed companies in the sector,

$$\overline{ROA}_M = \frac{1}{T}\sum_{t=1}^{T} ROA_{Mt},$$

$$ROA_{Mt} = \sum_{i=1}^{k} w_i * ROA_{it},$$

$$w_i = \frac{MV_i}{\sum_{i=1}^{k} MV_i},$$

MV_i – market value of company i.

$dS_M^2\left(\overline{ROA}_M\right)$ – semi-variance of the market portfolio determined in relation to the average level of ROA.

[9] A. Rutkowska-Ziarko, *Influence of profitability ratio and company size on profitability and investment risk in the capital market*, "Folia Oeconomica Stetinesia" 2015, 15(23), pp. 151–161.

[10] A. Rutkowska-Ziarko, C. Pyke, *The development of downside accounting beta as a measure of risk*, "Economics and Business Review" 2017, vol. 4, pp. 55–65.

The asymmetric mixed lower partial moment of the second degree for profitability ratios is calculated as follows:

$$CLPM_i^2\left(ROA\right)=\frac{1}{T-1}\sum_{t=1}^{T}\left(ROA_{it}-\overline{ROA}_M\right)*lpm_{Mt}\left(ROA\right), \tag{7}$$

where:

$$lpm_{Mt}\left(ROA\right)=\begin{cases}0 for\ ROA_{Mt}\geq\overline{ROA}_M\\ ROA_{Mt}-\overline{ROA}_M for\quad ROA_{Mt}<\overline{ROA}_M\end{cases}.$$

Similarly, the semi-variance of the ROA for the whole sector is calculated:

$$dS_M^2\left(\overline{ROA}_M\right)=\frac{\sum_{t=1}^{T}lpm_{Mt}S_M^2\left(ROA\right)}{T-1}. \tag{8}$$

The downside accounting beta (DAB) for profitability ratios could also be defined in a similar way.

2.2. Data

To test the application of DAB, the data for 27 Polish construction companies listed on the Warsaw Stock Exchange[11] was collected and analysed during the period 1 January, 2012–30 June, 2017. In addition, quarterly financial statements during the period between Quarter 4, 2011 and Quarter 1, 2017 were also analysed for the same 27 construction companies. The quarterly financial reports used by investors always refer to a company's performance in the previous quarter. Therefore, in this study, a quarter back-shift is applied to the financial data so that it matches the market share prices. A time series of quarterly rates of return and profitability ratios: ROA, ROE and ROS were determined for every company. In this study, we decided to use the sector index (WIG-construction) instead of the wide market WIG index. The Warsaw Interbank Offer Rate (WIBOR 3M) for three-month investment was used as the risk-free rate.

[11] The three-letter abbreviations used at the Warsaw Stock Exchange are used in the paper instead of the full names of stock issuers.

3. Empirical results

A time series of quarterly rates of return and profitability ratios: ROA, ROE and ROS was calculated for every company. For each construction company, the market betas and accounting betas were calculated using two different approaches: the risk measured by variance and downside risk (Table 1a and 1b).

Table 1a Estimates of market and accounting betas in the variance approach

Asset	$\bar{R}_i$	β_i	$\beta_i(ROS)$	$\beta_i(ROA)$	$\beta_i(ROE)$
AWB	0.337	1.344	5.900	5.025	0.351
BDX	0.069	1.009	1.179	1.483	2.074
CNG	0.013	0.639	–0.976	–0.809	–0.125
CNT	0.026	0.050	0.435	0.033	–0.003
DCR	0.027	0.820	0.811	0.662	0.175
ELB	0.023	0.829	0.471	0.226	0.045
ELT	0.036	0.544	0.052	–0.045	0.012
ENP	0.016	0.188	–0.153	–0.592	–0.221
ERB	0.042	1.063	0.119	0.199	0.147
ESS	0.006	0.693	0.119	–0.059	–0.073
HRS	0.268	1.947	1.885	0.389	0.037
INK	0.009	0.343	–0.895	–1.659	–0.502
LTX	0.046	0.296	5.748	2.897	0.667
MRB	0.012	1.385	–0.248	–0.370	–0.240
MSP	0.005	0.586	–0.432	–1.070	–0.285
MSZ	0.000	0.892	0.965	0.559	–0.106
NVA	0.016	0.356	–1.940	–1.376	–0.289
PJP	0.027	0.768	–2.702	–1.730	–0.343
POZ	–0.005	0.665	–0.940	–0.343	–0.104
PRM	0.025	0.470	–2.619	–2.106	–0.846
RFK	0.020	0.888	–0.464	–0.840	–0.862
RPC	0.035	0.504	0.199	–0.091	–0.039
SKA	0.051	0.175	1.571	1.718	0.919
TRK	0.410	2.452	2.728	2.747	0.532
ULM	0.032	0.955	–1.873	–1.358	–0.541
UNI	0.054	0.797	0.155	0.183	0.087
WAX	0.024	0.653	–2.270	–2.285	–0.613
Mean	0.060	0.789	0.253	0.051	–0.005

Source: Own work.

Table 1b. Estimates of market and accounting betas in the downside approach

Asset	$\bar{R}_i$	β_i^{LPM}	$\beta_i^{LPM}(ROS)$	$\beta_i^{LPM}(ROA)$	$\beta_i^{LPM}(ROE)$
AWB	0.337	0.980	12.016	10.970	2.922
BDX	0.069	0.759	1.012	0.821	0.615
CNG	0.013	0.456	–0.873	0.007	1.354
CNT	0.026	–0.016	0.938	0.730	1.360
DCR	0.027	0.916	1.622	1.761	1.574
ELB	0.023	0.616	0.739	0.326	1.030
ELT	0.036	0.411	–0.491	–1.542	0.931
ENP	0.016	0.239	0.038	–1.579	0.635
ERB	0.042	0.798	1.675	1.631	1.639
ESS	0.006	0.682	0.471	0.521	1.305
HRS	0.268	0.757	–0.113	1.298	1.393
INK	0.009	0.293	–0.695	–1.711	0.583
LTX	0.046	0.060	–2.036	0.049	1.329
MRB	0.012	1.233	0.752	0.752	1.039
MSP	0.005	0.486	2.852	2.667	2.016
MSZ	0.000	1.035	2.985	2.557	1.666
NVA	0.016	0.353	–2.788	–0.858	1.061
PJP	0.027	0.557	0.374	0.866	1.455
POZ	–0.005	0.625	–2.010	–0.098	1.095
PRM	0.025	0.362	0.338	0.197	1.062
RFK	0.020	0.682	2.709	1.886	1.138
RPC	0.035	0.254	–0.307	0.454	1.243
SKA	0.051	–0.174	0.345	–0.015	1.114
TRK	0.410	0.670	4.066	4.472	2.102
ULM	0.032	0.926	–1.791	–0.208	0.790
UNI	0.054	0.597	1.477	1.278	1.315
WAX	0.024	0.488	–4.293	–3.516	0.170
Mean	0.060	0.557	0.704	0.878	1.257

Notes: β_i – beta (with respect to the construction index); $\beta_i(ROS)$, $\beta_i(ROA)$, $\beta_i(ROE)$ – accounting betas (with respect to construction market indices respectively of profitability ratios ROS, ROA and ROE); β_i^{LPM} – downside beta (with respect to the construction index); $\beta_i^{LPM}(ROS)$, $\beta_i^{LPM}(ROA)$, $\beta_i^{LPM}(ROE)$ – downside accounting betas (with respect construction market indices respectively of profitability ratios ROS, ROA and ROE); $\bar{R}_i$ – mean quarterly return for asset i.
Source: Own work.

The market betas were calculated on quarterly rates of return. The rates of return were computed as relative increases in the prices of stocks according to the formula:

$$R_{it} = \frac{N_{i,t+s} - N_{it}}{N_{it}} \cdot 100\% \tag{12}$$

where:
s – is the length of the investment process expressed in days,
N_{it} – is the listed value (in this article close price) of security i at time t,
$N_{i,t+s}$ – is the listed value of security i after s days of investing started at time t.

In the period under investigation, only one company had a negative average rate of return. If an equally weighted portfolio had been bought, the investor would have received an average return of 6% per quarter. For each company, the market betas are positive, but there were two cases where the downside market beta is negative. There are many negative accounting betas, in fact more than half of the companies have a negative $\beta_i(ROA)$, which means that the return on assets of these firms changes in the opposite direction to the average return on assets within the construction sector. However, all $\beta_i(ROE)$ are positive; this means that, in a weak position, the return on equity for every analysed company moves in the same direction as the return on equity for the whole sector. The results show that downside accounting betas are, on average, higher than the classical equivalents. It is an interesting case of both the most profitable companies (AWB and TRK). The accounting betas of these companies are extremely high, especially for ROA and ROS. AWB and TRK are very sensitive for the situation in the construction sector. The systematic risk is very high, but investors receive higher profit in the same time on the capital market.

Next the Pearsons coefficients between the average rate of return and different kinds of betas were calculated (Table 2 and 3).

Table 2. Correlation between the average rate of return, market betas and accounting betas for the mean-variance and mean semi-variance approach

Betas	$\bar{R}_i$
β_i	0.772
$\beta_i(ROS)$	0.602
$\beta_i(ROA)$	0.664
$\beta_i(ROE)$	0.314
β_i^{LPM}	0.217
$\beta_i^{LPM}(ROS)$	0.588
$\beta_i^{LPM}(ROA)$	0.672
$\beta_i^{LPM}(ROE)$	0.585

Notes: Critical value of the correlation coefficient at the 5% level of significance is 0.381.
Source: Own calculations.

The average rate of return is positively correlated with all of the different markets and accounting betas. Although the correlation coefficients for the accounting beta for ROE and downside market beta are not statistically significant.

Table 3. Correlation between different kinds of betas

	β_i	$\beta_i(ROS)$	$\beta_i(ROA)$	$\beta_i(ROE)$	β_i^{LPM}	$\beta_i^{LPM}(ROS)$	$\beta_i^{LPM}(ROA)$	$\beta_i^{LPM}(ROE)$
β_i	1							
$\beta_i(ROS)$	0.302	1						
$\beta_i(ROA)$	0.374	0.949	1					
$\beta_i(ROE)$	0.170	0.595	0.688	1				
β_i^{LPM}	0.671	0.023	0.104	–0.057	1			
$\beta_i^{LPM}(ROS)$	0.420	0.566	0.659	0.207	0.383	1		
$\beta_i^{LPM}(ROA)$	0.520	0.623	0.717	0.236	0.430	0.945	1	
$\beta_i^{LPM}(ROE)$	0.426	0.571	0.633	0.143	0.276	0.819	0.908	1

Notes: Critical value of the correlation coefficient at the 5% level of significance is 0.381.
Source: Own calculations.

The Accounting betas for ROA and ROS are strongly correlated, it exists both for the downside and variance approach. Therefore, accounting betas, as well as market betas, have an important impact on the average rate of return. The highest correlation for accounting betas occurs for ROA.

4. Conclusion

In the period under investigation, only one construction company had a negative average rate of return. If an equally weighted portfolio had been bought, the investor would have received an average return of 6% per quarter. It can be said that Polish construction companies are attractive for investors on the capital market.

In the previous research it was found that there were significant correlations between market betas and accounting ones for the Polish food and construction sector.

In this paper it is shown that for the Polish construction sector accounting betas, as well as downside accounting betas, have an important impact on the average rate of return on the capital market. In the study we identified some companies with a very high level of systematic risk measured by accounting betas for ROA and ROS. It occurred that those companies (AWB and TRK) also received the highest average rate of return as compared to other analysed construction companies.

Looking at the accounting betas, the most correlated variables with the average rate of return are the accounting beta and downside accounting beta for ROA. It means that fluctuation in the profitability of assets has an important impact on profits for investors on the capital market. It seems that, for construction companies, the ability of using its assets in an effective way to make a profit is the key to success.

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Korelacja pomiędzy rentownością a księgowymi współczynnikami beta dla polskiego sektora budowlanego

Streszczenie

Przeanalizowano dane 27 polskich firm budowlanych notowanych na Giełdzie Papierów Wartościowych w Warszawie, w latach 2012–2018. Wykorzystano ceny zamknięcia i wskaźniki rentowności: ROA, ROE i ROS. Wyznaczono rynkowe współczynniki beta oraz księgowe współczynniki beta w kontekście wariancji i ryzyka dolnego. Następnie porównano je z kwartalną średnią stopą zwrotu dla każdego rozpatrywanego przedsiębiorstwa. Tylko jedna firma budowlana miała ujemną średnią stopę zwrotu. Można powiedzieć, że polskie firmy budowlane są atrakcyjne dla inwestorów na rynku kapitałowym. Stwierdzono, że dla polskiego sektora budowlanego księgowe współczynniki beta, a także dolne księgowe współczynniki beta, mają istotny wpływ na średnią stopę zwrotu na rynku kapitałowym. Oznacza to, że firmy budowlane najbardziej wrażliwe na sytuację w branży dały jednocześnie inwestorom najwyższe zyski na rynku kapitałowym. Najwyższa korelacja pomiędzy księgowymi współczynnikami beta a średnią stopą zwrotu wystąpiła dla ROA.

Słowa kluczowe: beta księgowa, ryzyko dolne, ROA, ROE, ROS, sektor budowlany