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Outstandingly High Values of the Market Value Ratios as a Symptom of Market Informational Inefficiency: A Study on the Warsaw Stock Exchange

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Abstract

Purpose: The purpose of this article is to examine whether the outstandingly high values of the market value ratios co-occurring with low levels of weak-form informational efficiency proxied by the percentage of the stock returns normality tests in which the null hypothesis could not be rejected.
Methodology: The weak-form informational efficiency measure used in the study is based on the strict random walk model proposed by Bachelier. The data collected covered the period from 31/12/2016 to 23/03/2020 and contained financial data of the companies listed on both stock markets of the Warsaw Stock Exchange (WSE), i.e. on the Main Market and NewConnect. The empirical study consisted in comparing the average market value ratios and the market efficiency measures calculated for both the WSE sectors and subsectors.
Findings: The analysis of the scatterplots as well as the analysis of the correlation coefficients suggest that the outstandingly high values of the market value ratios do not co-occur with low levels of weak-form informational efficiency. Thus, the outstandingly high values of the market value ratios cannot be treated as any clear indication of market inefficiency.
Research limitations: The authors encourage other researchers to test weak-form informational efficiency under more general conditions and repeat the study for other datasets.
Value: According to the authors' knowledge, it is the first study making an attempt to capture any connection between the extremely high values of the market value ratios and quantified informational market efficiency in a weak form.

Keywords: market value ratios, efficient market hypothesis, weak-form efficiency, stock markets, random walk.

JEL: G10, G12, G14

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Wyjątkowo wysokie wartości wskaźników wartości rynkowej jako przejaw rynkowej nieefektywności informacyjnej: badanie na Giełdzie Papierów Wartościowych w Warszawie

Streszczenie

Cel: celem artykułu jest zweryfikowanie czy ponadprzeciętnie wysokie wartości wskaźników wartości rynkowej współwystępują z niskimi poziomami efektywności informacyjnej, oszacowanej jako odsetek testów normalności rozkładów stóp zwrotu akcji, w których nie było podstaw do odrzucenia hipotezy zerowej.

Metodologia: miara efektywności informacyjnej w formie słabej, wykorzystana w badaniu, opiera się na rygorystycznym modelu błądzenia losowego zaproponowanym przez Bacheliera. Zebrane dane obejmują okres od 31 grudnia 2016 r. do 23 marca 2020 r. i zawierają dane finansowe spółek notowanych na obu rynkach akcji Giełdy Papierów Wartościowych w Warszawie (GPW), tj. na Głównym Rynku oraz NewConnect. Badanie empiryczne polegało na porównaniu średnich wartości wskaźników wartości rynkowej i miar efektywności informacyjnej, obliczonych dla sektorów i podsektorów GPW.

Wyniki: zarówno analiza wykresów rozrzutu, jak i analiza współczynników korelacji sugerują, że ponadprzeciętnie wysokie wartości wskaźników wartości rynkowej nie współwystępują z niskimi poziomami efektywności informacyjnej w formie słabej i nie mogą być traktowane jako jasne wskazanie występowania nieefektywności rynku.

Ograniczenia badawcze: autorzy zachęcają innych badaczy do testowania efektywności informacyjnej w formie słabej z wykorzystaniem bardziej ogólnych założeń oraz powtórzenia badania dla innych zbiorów danych.

Wartość: według wiedzy autorów to pierwsze badanie podejmujące próbę uchwycenia powiązań między ekstremalnie wysokimi wartościami wskaźników wyceny rynkowej a skwantyfikowaną efektywnością informacyjną rynku.

Słowa kluczowe: wskaźniki wartości rynkowej, hipoteza rynku efektywnego, efektywność w formie słabej, rynki akcji, błądzenie losowe.

1. Introduction

Outstandingly high values of the market value ratios are often identified with speculative bubbles, which are a clear symptom of informational market inefficiency. The issue-related literature mentions many examples of companies with extremely high market value ratios during speculative bubbles. For instance, at the end of 1999, when the historical P/E market-average value amounted to 15, its value for Yahoo! was 1300 and for eBay 3300. At the beginning of the following year, when investors realised that such a high market valuation had no reasonable grounds, they started to sell their stocks and the plunge began (Nofsinger, 2011). Such examples from the history incline market participants and observers to fault some stocks for being overpriced due to high market value ratios. In their view, high valuation comes from the irrational behaviour of the other market participants, which is related to the informational inefficiency of the market. Such accusations were thrown many times against the stocks

of some successful Polish video games companies. The above-mentioned constituted a motivation for this research, aiming for examining whether the outstandingly high values of the market value ratios co-occur with low levels of weak-form informational efficiency, proxied by the percentage of the stock returns normality tests in which the null hypothesis could not be rejected. The weak-form informational efficiency measure used in the study is based on the strict random walk model proposed by Bachelier, treated by many researchers as a synonym of weak-form informational efficiency proposed by Fama (1970) and Jensen (1978). The model of Bachelier says that if the returns on the financial asset are subject to the random walk, they have to be normally distributed (Czekaj, 2014). The data collected covered the period from 31/12/2016 to 23/03/2020 and contained financial data of the companies listed on both stock markets of the Warsaw Stock Exchange (WSE), i.e. on the Main Market and NewConnect. The empirical study consisted in comparing the average market value ratios and the market efficiency measures calculated for both the WSE sectors and subsectors. The analysis of the results was conducted with the use of the scatterplots and Pearson's correlation coefficients. An attempt to capture any connection between the extremely high values of the market value ratios and quantified informational market efficiency in a weak form constitutes a unique feature of this research.

Section 2 of this paper is devoted to a review of the literature pertaining to testing normality, random walk and informational efficiency of stocks and indexes. Section 3 presents the research methodology and the results of the study. Section 4 summarises the paper.

2. Literature Review

Studies dedicated to verification of the normality and the random walk of the returns on assets on financial markets are willingly conducted by researchers. Contemporary studies analyse distributions of the returns on whole indexes as well as single stocks. Buła (2014) examined whether the returns on the stocks included in the WIG20 index, in the period 02/01/1995–18/07/2012, were subject to the random walk process. Three groups of verification techniques were applied, i.e. unit-root tests, randomness tests and autocorrelation tests. The results did not clearly suggest rejecting the null hypothesis saying that the stock returns were described by the random walk process. Borowski (2017) examined whether the returns on the components of the following WSE indexes: WIG20, mWIG40 and sWIG80 had normal distribution. The results of the normality tests conducted indicated that the hypothesis saying that returns had normal distribution should be rejected. What is more, Borowski (2018) analysed if the whole indexes on the WSE had normal distribution. The verification of statistical

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hypotheses was conducted for the returns on the following pairs of prices: closing-closing, opening-opening, opening-closing and overnight. The results indicated that the analysed WSE indexes did not follow a path of normal distribution. Witkowska and Żebrowska-Suchodolska (2008) examined if the returns distributions followed the random walk process for the WIG20 index and the sub-index WIG-BANKI (representing the banking sector of the stocks listed on the WSE), in the period from 03/10/1994 to 29/12/2006. The tests of Quenouill and Ljung-Box suggested that informational efficiency in a weak form occurred in the examined period. Żebrowska-Suchodolska and Mentel (2018) conducted research to verify the hypothesis of weak-form efficiency of the WIG index, which represents all stocks listed on the WSE. Data contained the daily returns from the period 2010–2016. The results indicate a weak form of market efficiency. Jamróz and Kilon (2015) verified the efficient market hypothesis (EMH) hypothesis for the futures contracts listed on the WSE in the period from January 2002 to June 2014. The results for futures, based on the WIG20 and WIG40 indexes and the currency indexes (FEUR, FUSD, FCHF), mostly indicate that the distributions of the returns do not reflect the random walk process.

Moving on to the studies devoted to the European markets, Smith (2012) examined whether 15 European emerging stock markets were subject to the random walk. The researcher applied the rolling window variance ratio tests for the returns over the period beginning in February 2000 and ending in December 2009. The UK, Turkish, Hungarian and Polish markets proved to be the most efficient ones during the considered research period. The least efficient ones were the Maltese, Ukrainian and Estonian stock markets. There has been a study conducted on informational efficiency in a weak form on the capital markets in Eastern Europe and developed markets in Western Europe by Regep (2015). In the paper mentioned, the researcher focused on a detailed analysis of high frequency data, for each company being a part of the indexes examined. The research period considered was October 2012–April 2013. The researcher achieved different results pertaining to the weak-form efficiency, depending on the frequency, region and sector considered. The research conducted by Borges (2010) examined whether 6 selected European stock markets were weak-form efficient in the period from January 1993 to December 2007. The results reached indicate that market efficiency depends on the market and the period taken into consideration. The study does not support the thesis that efficiency develops over time.

According to the authors' knowledge, there is a lack of studies making an attempt to capture any connection between the extremely high values of the market value ratios and quantified informational market efficiency in a weak-form. Nevertheless, there are some studies proposing that there is an informational content in the market value ratios which suggests that

with their use, the prices of financial assets can be predicted. Thus, they indicate informational inefficiency of financial markets. Rutkowska-Ziarko and Sachoń (2014) examined if the WSE-listed stocks from the construction industry, with low and medium values of the market value ratios, generate more profit than stocks with the high ones. The results of the study suggest that the portfolios including stocks of companies with low and medium values of the market value ratios were more profitable that the other ones. Sun (2012) verified the EMH for the Australian stock market. The point was to examine if it is possible to forecast future prices of stocks on the basis of P/E, P/BV ratios and the size of a company. Results based on a five-year period showed that the above-mentioned indicators reveal some predicting power especially in a long-term investment horizon. Treivino and Robertson (2002) suggest that the P/E ratio and the P/BV ratio have some explanatory power in the long-term predictions of the value of stock prices. The research was performed on the US stock market data for a 5-year holding period.

3. Research Methodology and Empirical Results

Verification of the research hypothesis proposed, saying that the outstandingly high values of the market value ratios co-occur with low levels of weak-form informational efficiency, consisted of a few steps described below. All data used for the purpose of this research was collected from the Thomson Reuters Eikon database. The goal of the first step of the research was to calculate P/E (Price/Earnings) and P/BV (Price/Book Value) market value ratios for each stock market sector and subsector of the Warsaw Stock Exchange (WSE) according to the WSE classification. The choice of these ratios was based on the studies by Treivino and Robertson (2002) and Sun (2012), mentioned in the literature review section above. This step began with the selection of the companies listed on both the Main Market and NewConnect of the WSE, at least from 31/12/2016. An additional assumption made was that the companies had to be active as at 23/03/2020 in order to ensure complete data in the whole research period from 31/12/2016 to 23/03/2020. On 23/03/2020, i.e. on the day of collecting data for the purpose of the study, the financial results of many companies as at 31/12/2019 were not available yet, thus Q3 2019 was the last quarter, at the end of which the market value ratios were calculated. Both above-mentioned market value ratios, namely P/E and P/BV, were calculated for each company as at the end of each quarter, using variables downloaded from the Thomson Reuters Eikon database. All calculations done for the purpose of this study were performed in Microsoft Excel. The P/E ratio was calculated as at the end of each quarter by dividing a closing market price at the end of the last working day of the quarter by the accumulated

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earnings per share from the last 4 quarters. The P/BV ratio was calculated as at the end of each quarter by dividing a closing market price at the end of the last working day of the quarter by the average equity per share from the last 4 quarters. In the case of both the P/E and P/BV ratios, when the denominator was negative, the ratio was not calculated. According to the next assumption of the study, when some missing data (missing in the Thomson Reuters Eikon database) did not enable the researchers to calculate more than 3 out of 12 market value ratios, the company was rejected from the sample. Both market value ratios calculated at the end of each quarter were averaged at the level of each company. Then, taking into account these average market value ratios calculated for each company separately, the average values were calculated for the WSE stock market sectors and subsectors according to the WSE classification.

The goal of the second step of the research was to perform some normality tests of daily logarithmic stock returns and calculate the percentage of the normality tests performed, in which the null hypothesis (saying that the distribution of daily returns was normal) was not rejected, for each stock market sector and subsector of the WSE according to its classification. This variable is used as a proxy for informational efficiency in a weak form. Many researchers still consider the random walk model proposed by Bachelier in 1900 to be a synonym of weak-form informational efficiency proposed by Fama (1970) and Jensen (1978). The above-mentioned model says that if the returns on the financial asset are subject to the random walk, they have to be normally distributed (Czekaj, 2014). Many researchers still use this model in their studies on weak-form informational efficiency, even though the assumption of the model about the normality of returns distribution seems to be too strict, especially taking into account their common fat tails and asymmetry.

For the purpose of this study, 3 normality tests were performed, namely the Expanded Shapiro-Wilk test, the D'Agostino-Pearson test and the Jarque-Barre test. The normality tests mentioned were run in Microsoft Excel using The Real Statistics Resource Pack add-in. Each normality test returns a p-value, i.e. a test probability. Due to a diverse nature of these tests, the p-values may be different. In each normality test applied, the null hypothesis says that the distribution of the empirical returns is compatible with normal distribution. The null hypothesis is rejected for the benefit of the alternative one (stating that the distribution of the empirical returns is not compatible with normal distribution) when the p-value resulting from the normality test is less than the significance level of $\alpha = 0.05$. The normality tests were conducted for daily logarithmic stock returns in 30, 60 and 100-session rolling windows. This methodology is based on the approach proposed by Borowski (2017). When the test is conducted for the first window, the window moves by 1 session forward, up to the end of the research period. The assumption related to this part of the study

stated that each test required at least 75% of daily returns to be run. This assumption came from the bias of missing data. The next assumption pertaining to this part of the study stated that when for a given company less than 90% of tests possible to perform were run, the company was rejected from the research sample. The average percentage of the null hypotheses which could not be rejected was calculated for each company and then for each sector and subsector of the WSE according to its classification.

Taking into account all the assumptions made, the final research sample consisted of 215 companies, where 200 companies came from the Main Market of the WSE and only 15 companies were listed on the NewConnect. Table 1 summarises the calculations performed in steps 1 and 2 of the research and presents the average results of the WSE sectors. The first column indicates the name of the WSE sector while the next columns present respectively: the number of the companies analysed in the sector, the average value of the P/E ratio of the sector, the average P/BV ratio of the sector and the average percentage of cases in which there were no grounds to reject the null hypothesis in the normality tests.

WSE Sector	Count	Average P/E	Average P/BV	Average H0 %
Chemistry and primary commodities	22	29.01	1.14	18.32
Commerce and services	30	56.16	5.21	18.99
Consumption goods	19	20.87	3.46	23.69
Finance	47	16.92	2.12	18.81
Fuel and energy	14	31.23	3.80	17.74
Health care	15	41.98	8.35	19.80
Manufacturing, construction and assembly	47	26.29	1.24	18.12
Technology	21	30.99	2.89	19.96

Tab. 1. Final research sample and the average results of the WSE sectors. Source: Own elaboration.

As Table 1 presents the results of the calculations for the WSE sectors, Table 2 presents the results of the calculations done for the WSE subsectors. Systematisation of data in particular columns remained the same as in Table 1.

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WSE Subsector	Count	Average P/E	Average P/BV	Average H0 %
Chemistry and primary commodities: mining	4	31.39	0.87	18.58
Chemistry and primary commodities: chemistry	6	55.55	1.34	19.97
Chemistry and primary commodities: metallurgy	6	12.84	1.44	22.92
Chemistry and primary commodities: wood and paper	1	10.87	0.48	10.75
Chemistry and primary commodities: recycling	2	19.25	0.77	12.72
Chemistry and primary commodities: gum and synthetics	3	17.67	0.99	11.75
Commerce and services: games	8	118.98	8.97	26.01
Commerce and services: commerce networks	3	26.09	3.23	14.14
Commerce and services: recreation and leisure	4	59.59	10.63	19.21
Commerce and services: media	9	34.54	2.69	18.33
Commerce and services: wholesale commerce	5	9.45	1.42	13.29
Commerce and services: e-commerce	1	58.34	1.11	11.00
Consumption goods: clothing and cosmetics	4	26.21	3.07	30.63
Consumption goods: groceries	9	22.74	4.62	22.73
Consumption goods: fitting	2	14.47	1.77	22.79
Consumption goods: motorisation	4	14.52	2.06	19.38
Finance: insurance	4	51.10	9.24	16.58
Finance: banks	12	12.76	1.02	24.21
Finance: accounts receivable	2	9.41	1.75	18.58
Finance: capital market	5	9.87	2.59	21.44
Finance: real assets	15	17.20	1.11	15.43
Finance: investment activity	6	10.52	0.98	20.27
Finance: financial intermediary	3	16.19	3.85	9.90
Fuel and energy: fuel and gas	5	19.18	6.95	17.30
Fuel and energy: energy	9	37.92	2.05	17.98
Health care: equipment and medical materials	7	15.38	15.36	20.37

Table cont.

WSE Subsector	Count	Average P/E	Average P/BV	Average H0 %
Health care: drugs production	5	99.22	2.18	14.42
Health care: drugs distribution	1	13.55	2.26	49.11
Health care: biotechnology	1	11.47	3.79	9.33
Health care: hospitals and clinics	1	1.03	0.72	23.78
Manufacturing, constr. and assembly: construction	27	27.44	1.27	18.24
Manufacturing, constr. and assembly: transport and logistics	4	10.15	1.24	20.63
Manufacturing, constr. and assembly: electromech. industry	7	16.18	1.31	21.15
Manufacturing, constr. and assembly: supply for business	4	58.49	0.94	15.86
Manufacturing, constr. and assembly: services for business	5	21.39	1.26	12.96
Technology: telecoms	4	98.04	1.14	28.96
Technology: IT	17	15.22	3.30	17.85

Tab. 2. Final research sample and the average results of the WSE subsectors. Source: Own elaboration.

The data included in Table 1 constituted the basis for preparation of the scatterplots presented in Figures 1 and 2. Figure 1 presents a scatterplot in which the average percentage of the normality tests with retained null hypotheses is indicated on the Y axis and the average P/E ratio is indicated on the X axis. Figure 2 presents a scatterplot in which the average percentage of the normality tests with retained null hypotheses is indicated on the Y axis and the average P/BV ratio in indicated on the X axis. Each point refers to a particular WSE sector. The triangle refers to an average result calculated at the level of the companies. The spread of the results pertaining to the percentage of cases with the null hypothesis which was not rejected is moderate and ranges from 17.74% to 23.69%. The spread of the average P/E ratios is much larger and ranges from 16.92 to 56.16. A similar case refers to the average P/BV ratios ranging from 1.14 to 8.35. Two WSE sectors stand out taking into account the P/E and P/BV ratios, namely Commerce and services and Health care. Their outstanding market value ratios do not co-occur with the outstandingly low percentage of the null hypotheses rejected in the normality tests. This suggests that the research hypothesis has to be rejected.

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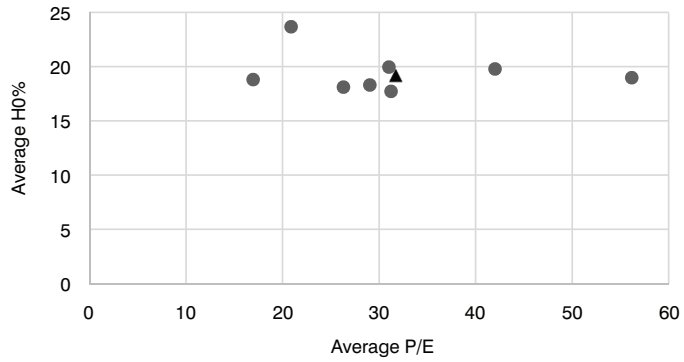

Fig. 1. A scatterplot for the average values of the P/E ratio and the average percentage of the normality tests in which there were no grounds to reject the null hypothesis, for particular WSE sectors. Source: Own elaboration.

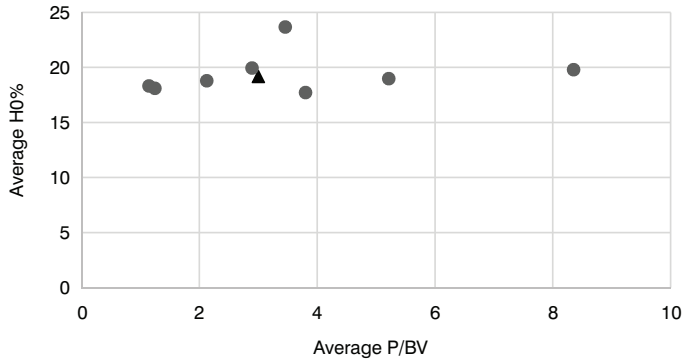

Fig. 2. A scatterplot for the average values of the P/BV ratio and the average percentage of the normality tests in which there were no grounds to reject the null hypothesis, for particular WSE sectors. Source: Own elaboration.

Data included in Table 2 constituted the basis for preparation of the scatterplots presented in Figures 3 and 4. Figure 3 presents a scatterplot in which the average percentage of the normality tests with retained null hypotheses is indicated on the Y axis and the average P/E ratio in indicated on the X axis. Figure 4 presents a scatterplot in which the average percentage of the normality tests with retained null hypotheses is indicated on the Y axis and the average P/BV ratio in indicated on the X axis. Each point refers to a particular WSE subsector. At the level of the WSE subsectors, the spread of the results pertaining to the percentage of cases with the null hypothesis which was not rejected is much larger compared to sectors and ranges from 9.33% to 49.11%. Nevertheless, there is only one outstanding subsector

to which the highest value refers, namely Health care: drugs distribution. In the case of the average values of the P/E ratio, there are especially 3 subsectors with outstandingly high values, i.e. Commerce and services: games (118.98), Health care: drugs production (99.22) and Technology: telecoms (98.04). Looking at Figure 4, 5 subsectors have outstandingly high values of the P/BV ratios, namely Health care: equipment and medical materials (15.36), Commerce and services: recreation and leisure (10.63), Finance: insurance (9.24), Commerce and services: games (8.97) and Fuel and energy: fuel and gas (6.95). Again, as in the case of the data analysis at the sectors level, none of these outstandingly high values of the market value ratios co-occur with the outstandingly low percentage of the null hypotheses which could not be rejected.

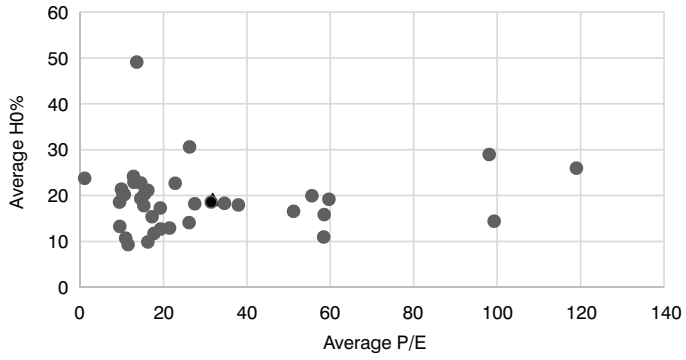

Fig. 3. A scatterplot for the average values of the P/E ratio and the average percentage of the normality tests in which there were no grounds to reject the null hypothesis, for particular WSE subsectors. Source: Own elaboration.

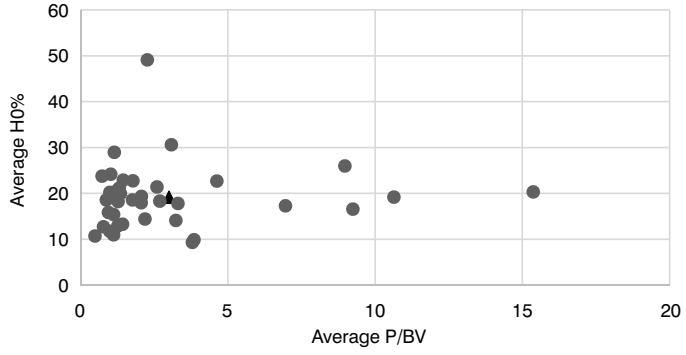

Fig. 4. A scatterplot for the average values of the P/BV ratio and the average percentage of the normality tests in which there were no grounds to reject the null hypothesis, for particular WSE subsectors. Source: Own elaboration.

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Table 3 presents Pearson's correlation coefficients and their p-values calculated for the pairs of the variables presented in Figures 1–4 above. Pearson's correlation coefficients were calculated to additionally support the conclusions drawn from the analysis of the scatterplots. P-values of the correlation coefficients indicate that in all cases the correlation between the market value ratios and the percentage of the null hypotheses in the normality tests which could not be rejected is low and statistically insignificant.

Division	Scatterplot	Variable 1 (X axis)	Variable 2 (Y axis)	Pearson	p-value
Sectors	Figure 1	Average P/E	Average H0 %	-0.20	0.64
Sectors	Figure 2	Average P/BV	Average H0 %	0.21	0.64
Subsectors	Figure 3	Average P/E	Average H0 %	0.06	0.71
Subsectors	Figure 4	Average P/BV	Average H0 %	0.06	0.73

Tab. 3. Pearson's correlation coefficients and their p-values, calculated for the correlation between the average market value ratios and the average percentage of the normality tests in which there were no grounds to reject the null hypothesis. Source: Own elaboration.

The analysis of the scatterplots as well as the analysis of the correlations suggest that the outstandingly high values of the market value ratios do not co-occur with low levels of weak-form informational efficiency proxied by the percentage of cases of the stock returns normality tests in which the null hypothesis could not be rejected. Thus, the results suggest that the null hypothesis of the research should be rejected.

4. Conclusion

An attempt to capture any connection between the extremely high values of the market value ratios and quantified informational market efficiency in a weak form constitutes a unique feature of this research. The results of the study suggest rejecting the research hypothesis saying that the outstandingly high values of the market value ratios co-occur with low levels of weak-form informational efficiency proxied by the percentage of cases of the stock returns normality tests in which the null hypothesis could not be rejected. The results of the study also suggest that the outstandingly high market value ratios may not be always related to informational inefficiency of the market. Hence, some accusations of being overpriced due to irrational behaviour of the market participants, thrown against the companies with high market value ratios, may be unjustified. According to the authors' knowledge, it is the first study making an attempt to capture any connection

between the extremely high values of the market value ratios and quantified informational market efficiency in a weak form.

Taking into account that this study applied the very strict random walk model proposed by Bachelier in order to verify informational efficiency of stocks, the authors encourage other researchers to apply other tools (especially less strict ones) for the efficient market hypothesis verification in future research.

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