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THE EFFICIENCY OF STOCK MARKET INDICES IN POLAND – THE EMPIRICAL EVIDENCE

Summary: Investors on the stock market evaluate the performance of their portfolios in terms of the rate of return that is achievable. Furthermore, often the analysis of risk connected with an investment is taken into consideration. The relation between these two categories can serve to assess various assets in the context of efficient portfolios in Markowitz's sense. The more positive this relation is, the more efficient is a portfolio. The article is based on the empirical study of efficiency of stock market indices quoted on the Warsaw Stock Exchange and their development throughout the years of 2008-2013. There are 11 sector indexes, WIG20 and WIG compared to each other in the research. The article focuses on the practical application and description of efficiency measurement methods such as Sharpe Ratio, Jensen Alpha, Treynor Ratio, Information Ratio, and Sortino Ratio. It also discussess values of Pearson's correlation and beta coefficient which is evaluated with the use of linear regression model. The aim of the study is to evaluate the most efficient indexes (treated as potential portfolios and investment objectives) and to compare their efficiency with WIG. This is done by the comparative analysis of the values of selected efficiency measures. Results are presented in the form of ranking. It emphasizes portfolios (indexes) of shares which had the relation of risk and return better than other indices. As a consequence, such an approach helps potential investors in selecting potentially the most efficient sectors and groups of stocks quoted on the market.

Keywords: efficient portfolios, Sortino ratio, Sharpe Ratio, Treynor Ratio, Jensen's alpha.

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1. Introduction

Portfolio analysis is a useful method for investors who want to rely on the scientific models tested by researchers rather than to rely on their own intuition or circulating rumours.Comparing it to fundamental and technical analysis, it is a relatively new approach to investment cases. It links the elements of finance, management and numerical methods. According to Markowitz portfolio selection [1959], each well diversified portfolio is efficient on the efficient market. Investing in portfolio which

with a given level of risk generates the maximum rate of return or with a given level of the rate of return has the given level of risk is possible. In practice, it is difficult to find efficient portfolios. Such a situation is caused also by the lack of Markowitz's postulates fulfillment, e.g. portfolios not diversified enough [*Rynki, Instrumenty*…2008, pp. 443-446; Brealey, Myers 1999]. It is widely known that the strongest emphasis should be laid on the qualitative advantageous caused by diversification [Tarczyński 1997, pp. 75-76]. On the Warsaw Stock Exchange there are a lot of stock indices quoted. They consist of stocks from the same branches. As a result, they are not well diversified in Markowitz's sense due to the occurrence of the identical types of risk in the same industries. However, it is obvious that such indexes can be treated by investors like portfolios created by buying shares which are included in subsequent indexes. These portfolios are characterized by different levels of risk and rate of return. Therefore, there are various levels of efficiency. In general, the index consisting of all stocks quoted on the market can be believed to be properly diversified. On the other hand, sector indexes composed of firms from the same industry seem to be poorly diversified. From the theoretical point of view, broad market indexes, such as WIG, ought to be by far more efficient than non-diversified sector indexes. It is an incentive to conducting the research to check if in Polish conditions such a relationship really exists. It would be verified whether WIG index is actually more efficient than sector indices. Therefore, the subject of this article is the efficiency of stock market indexes quoted on the Warsaw Stock Exchange. In this text, the term 'most efficient' is used which indicates that in a given period an index had relatively higher values of efficiency ratios than other indices, so it is potentially 'most efficient'.

The aim of this article is to indicate the most efficient sector indices on the Polish capital market (the Warsaw Stock Exchange) on the basis of the data from 2008-2013. In this approach indexes are treated as investment portfolios. The measurement of efficiency requires also the assessment of the rate of return of indexes in the context of risk connected to them. In this article the quantitative research has been conducted.

The research hypothesis has been formulated: ranking method can show sector indices which are more efficient than others in years 2008-2013 and their relative efficiency is stable.

The research focuses on the practical application and description of efficiency measurement methods such as Sharpe Ratio, Jensen Alpha, Treynor Ratio, Information Ratio, and Sortino Ratio. Ratios have been calculated for each index which enabled to classify them in rankings in terms of their efficiency. Partial rankings served as stages to build the final ranking which informed about the total efficiency of consecutive indexes. It also discusses values of Pearson's correlation and beta coefficient which is evaluated with the use of linear regression model.It is crucial to emphasize that rankings creation in the context of efficiency measures is the author's own developed method.

The article consists of several parts. In the beginning, the state of the art in Poland has been presented. Next part introduces theoretical aspects of efficiency measures such as Sharpe, Treynor and Sortinoratio and Jensens's alpha. The third part is the description of the methodology of the research. The fourth subsection concerns the discussion of results of the research which finally leads to conclusions.

2. Literature overview

The measurement of the efficiency of sector indices is the relatively new approach on the Polish capital market. Although there are a lot of studies over the efficiency of investment funds, there is a kind of a research gap in the field of stock indexes efficiency. In this article, sector indices are treated as portfolios which people can invest in. Of course, such portfolios, with the exception of WIG and WIG20, are not diversified well due to the fact that they embrace companies from the same industries only. For instance, WIG-FOOD index includes enterprises engaged in a foodstuff production. Risks affecting this branch of the economy influence rates of return of all companies in this index. So, by buying a portfolio with the same composition as WIG-FOOD, an investor is exposed to the potentially excessive risk. In normal circumstances, such a behavior would not be desirable. However, the aim of this article is to check which sector index is the most efficient. Consequently, a real, well diversified portfolio would comprise of dozen of stocks from several most efficient indexes. Therefore, the indication of sector indexes which have the best relationship between risk and return may play an important role in the process of stock selection.

As stated above, such an approach to measure the efficiency of indexes is rare on the Polish stock exchange. There are a lot of papers devoted to investment funds efficiency and the efficiency of the Warsaw Stock Exchange in the context of Efficient Market Hypothesis which evaluate market efficiency in the light of weak, semi-strong or strong form of market efficiency. Exemplary research on Polish market prepared, inter alia,by A. Waszkowski [2011], K. Jurek-Wasilewska [2014] and P. Jamróz [2013].

When it comes to researchbased on the Polish capital market, there are some which utilize such measures of efficiency as Sharpe ratio, Treynor ratio and Jensen's alpha. For example, M. Salamaga [2013] used these ratios to evaluate efficiency of several selected investment strategies based on the technical analysis on indexes: WIG20, mWIG40, sWIG80. He also used the measures of market timing. Strategies utilized moving averages of prices. T. Brzęczek [2004] compared the efficiency of portfolios with WIG index. Portfolios were created by the specific procedure which ensured the control of the specific risk. It occurred to be successful as their level of efficiency was greater than WIG level. Other attempts to measure index efficiency concentrated around individual sector indexes or a specific RESPECT index. M. Kruk [2013] measured the total and systematic risk of construction industry quoted on the WSE. A. Sobieraj [2014] analysed the risk and return of energy industry on the WSE.

This study compared the outcomes of WIG-ENERGY with other sector indices and tried to verify if including companies from energy industry in a diversified portfolio was worth recommending. The study proved that these companies were relatively less risky, however, had lower rates of return. The author suggested prolonging the period studied which would probably give evidence of higher efficiency of WIG-ENERGY in the period 2005-2013. This sector was also an object of a study of J. Gajdka and T. Schabek [2013]. They presented similar findings. They claimed that the analysis based on the historical quotations from 3 years did not enable them to draw any clear conclusion about the general efficiency of this sector. However, this short period made it possible to assess that such companies are relatively less volatile than the rest of the market. M. Bojańczyk [2013] analyzed the historical changeability of index prices in Poland − WIG and compared the results with NYSE and FTSE100. The author estimated several statistics such as median, average and standard deviation. P. Trippner [2011] evaluated the advantages on diversification in the context of return and risk. The study proved that the proper diversification (adding 'safe' securitiesto portfolios) might remarkably reduce potential losses on the bearish market. In such a case the efficiency of investment can be on increase.

Another papers studied the efficiency of indexes of socially responsible companies across countries. In Poland such enterprises are included in RESPECT index. The efficiency of this index was measured by T. Jedynak [2012] and in different article by M. Bartkowiak and B. Janik [2013]. The first paper proved that the difference in profitability between WIG and RESPECT index was not statistically significant. Nevertheless, in terms of Sharpe ratio it is more efficient than WIG. Concurrently, the study was conducted on the short time frame so it is not desirable to draw any general conclusion. The second paper compared Polish index with WIG-BANKI, WIG-PALIWA and 2 social responsible indexes quoted on the Vienna Stock Exchange. RESPECT index was relatively more efficient.

Presented literature does not refer to the holistic approach for the Warsaw Stock Exchange, namely, authors in these articles did not compare the efficiency of all sector indices quoted on the market. It constitutes the gap which served as one of motives for conducting the research over the efficiency of sector indices in 2008-2013.

3. Measurement of the portfolio efficiency by means of Sharpe, Treynor, Jensen, Informationand Sortino ratios

Portfolio analysis provides tools for measuring the efficiency of portfolios such as [Tarczyński 1996, pp. 176-186]:

- Sharpe ratio,
- Treynor ratio,
- Jensen ratio,
- Sortino ratio,
- Information ratio.

Efficient portfolios in the Markowitz's sense are those which maximize the rate of return with the set level of risk and those which minimize risk with the set level of return. Investors often minimize their risk by diversification – by buying the group of securities from different sectors. Such a strategy would lead to the minimization of standard deviation of the whole portfolio [Kevin 2004, p. 133]. Portfolio which is the most efficient amongst others is potentially the best investment goal. It is a different approach in comparison with approaches of many inexperienced investors who attach weight only to the rate of return and do not consider risk at all. A trader looking for efficient portfolios would potentially prefer securities which offer lower prospects of growth, but their quotations are stable, rather than by far riskier securities with higher probability for remarkable rate of return. In such a case, efficiency is the crucial matter. In general, it can be calculated as a quotient of risk and return. To the most popular indicators utilized to measure efficiency of portfolios belong the following ratios: Sharpe, Jensen, Treynor, Sortino and Information ratio. Sharpe performance index can be calculated by the formula:

$$S_h = (R_i - R_f) / S_i,$$

where: R_i – the average return on portfolio in the certain period of time, R_f – the average risk-free rate of return in the same period of time, S_i – standard deviation of portfolio return in the same period of time.

This index uses standard deviation to measure risk. The return in excess is counted as the difference between return on portfolio and risk-free rate of return. It does refer to the total risk (measured by the standard deviation), not only to the systematic one. Sharpe ratio informs about the risk premium on the entity of total risk. It is a widely used measure, especially while evaluating performance of investment funds. Negative impact on its value can have both excessive losses and gains [Mayo 2011, p. 220; Reilly, Brown 2001, p. 670; Perez and Truszkowski 2011, pp. 171, 175]. In the research it was necessary to make an assumption concerning return of the market and the risk-free rate of return. First and foremost, the risk-free rate of return has been estimated on the basis of two-year bonds issued by the Polish government. The market yield stands for the rate of return of WIG index. People assume that yearly rate of return of these debt instruments is devoid of risk. Furthermore, the investment in government debt is believed to be safe owing to the fact that the state of insolvency of any country is very unlikely. Jensen ratio can be counted by the formula:

$$\alpha = (R_i - R_f) - \beta_i \times (R_m - R_f),$$

where: α – the value of Jensen alpha of a portfolio in the certain period, β – systematic risk of portfolio, R_m – expected rate of return from market portfolio.

This measure includes security's required rate of return and the excessive return of a portfolio. It is often used to create risk-adjusted rankings of investment funds. Jensen ratio relies on the CAPM model and constitutes the expected yield on a secu-

rity. The most successful managers of investment funds work out the highest alpha [Reilly, Brown 2001, pp. 672-673; *Transcending horizons*… 2009, p. 145]. Treynor ratio can be calculated by the formula:

$$Ti = (R_i – R_f) / \beta_i$$

It was the first ratio that covered risk. The application of systematic risk of a portfolio (β_i) checks to what extent is a portfolio sensitive to market risk and the rate of return of a market. The higher is the Treynor ratio, the better is the portfolio of investors. The difference between portfolio return and risk-free return is the risk premium. Risk – aversed investors should maximize the value of this ratio [Reilly, Brown 2001, pp. 666-667].Treynor ratio, on the contrary to Sharpe ratio, utilizes beta coefficient. It is the measure of non-diversifiable risk, whereas standard deviation is the measure of the total risk [Elton, Gruber 1998, pp. 792-793].Thus, Treynor ratio takes into account only this component of risk that cannot be eliminated by investors. It is the relevant sort of risk that cannot be diversified [Brigham, Houston 2004, pp. 168, 188-189]. Sortino ratio can be worked out by the formula:

$$Sor = (R_i – MAR_i) / dd_i,$$

where: Sor – Sortino ratio value, MAR_i – minimum accepted rate of return in the certain period, dd_i – semideviation of return on a portfolio.

This ratio was introduced in 1980s by F. Sortino. It gained popularity amongst hedge funds owing to the fact that it improved the way it presented the performance of portfolios in comparison with Sharpe ratio. The minimum accepted rate of return can be, for example, the risk-free rate. Sortino ratio takes into consideration only downside risk – risk of falling value of portfolio. It is the influence of the semideviation in the formula. The entire volatility of a portfolio is not reflected, merely the volatility called as adverse. Such an attitude is positively welcomed amongst investors who do not perceive excessive profits as risk. In this context, any hikes in value do not change this ratio. Sortino ratio constitutes the modification of Sharpe ratio. It is believed to be a satisfactory measure for investments which can be characterized by high volatility. However, portfolios with a very low standard deviation are often analyzed by other measures. It is commonly used to assess performance of stock funds and hedge funds [Sortino 2010, p. 24; Ridley 2004, p. 120; Perez, Truszkowski 2011, p. 175].

Information ratio can be calculated with the following formula [Perez, Truszkowski 2011, p. 174]:

$$IR = R_{ex} / TE,$$

where: R_{ex} – excess return of a portfolio, TE – tracking error-standard deviation of excess rate of return of a portfolio.

It is important to add that excess rate of return is counted as the difference between the rate of return of a portfolio and the rate of return of a benchmark. For the

purposes of a study it has been assumed that WIG index plays the role of a benchmark. Sharpe ratio in its basic form has some drawbacks. The attempt to eliminate these drawbacks constitutes the genesis of Information ratio. Sharpe ratio can lead to misinterpretations in situations of high volatility of the risk-free rate of return. Information ratio passes over the risk-free return, so it gives valuable indications that are independent of classical Sharpe ratio version [Perez, Truszkowski 2011, p. 174]. In literature, the computation of alpha is presented also in other way as alpha divided by tracking error. In general, tracking error and alphas of portfolios depend on the skills of managers as well as the aggressiveness factor. It is mainly reported on the annualized basis [Lee 2000, pp. 41-42]. It gives very significant information in the field of active management as it indicates how much additional return has been generated per unit of additional risk. Anyway, it is one of the most useful ratios in the asset management industry [Schneider 2010, pp. 1-3].

4. Methodology of the research

The research consists of six main stages. All of them have been listed in Figure 1. Stage 1 concerns several assumptions taken to the study. The time frame has been set for 2008-2013 so data from these years is the basis for calculation. There were two reasons for the selection of this period. The first one is connected with the market fluctuations – different types of trend that occurred. In 2008 there was a very sharp decline in prices on the Warsaw Stock Exchange. It was in the middle of a global financial crisis. The bearish market lasted to February 2009. Then, a very rapid bullish trend started. In 2011-2012 the horizontal trend prevailed with some short-term upward and downward trends. In consequence, the efficiency of indexes has been verified in various market conditions which makes the results more reliable. The second reason is linked with the availability of data – at the end of 2013 there were in total 11 indices quoted. First of them were published in 1998. However, the rest were published systematically later – in 2004, 2005, 2007, 2008, 2009 and 2010. So, to compare and contrast the efficiency of indices, it was desirable to choose the time frame embracing the quotations of the majority of indices. Table 1 presents the date of publication of consecutive indexes.

The subject of the research has been limited to sector indexes so as to verify which industry quoted on the Warsaw Stock Exchange was the most efficient. There were also 2 other indices taken to the consideration, namely, WIG and WIG20. The first one has been treated as a benchmark. The value of ratios of the second one has been counted in order to ensure the comparative basis for other indexes. Furthermore, WIG20 can also be treated as an investment portfolio, especially because there are numerous ETF, futures and options which are based on WIG20 which enable investors to buy or sell the index easily. Another thing worth bearing in mind is the presumption that every sector index can be treated as a portfolio which can be bought or sold by investors any time they want to.

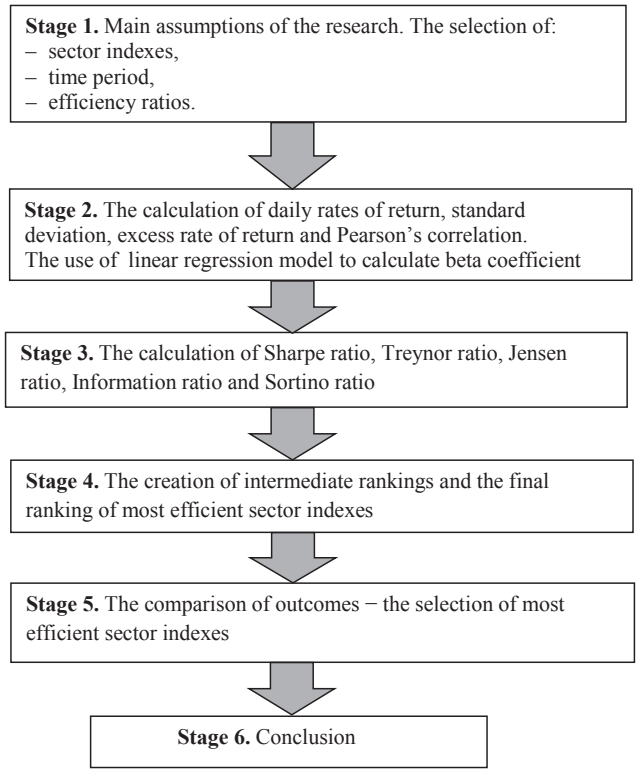

Figure 1. The stages of the research

Source: own study.

Table 1. The first day of quotation of subsequent indexes

Sector index	Date of publication
WIG-BANKS	31.12.1998
WIG-CONSTRUCTION	31.12.1998
WIG-CHEMICALS	19.09.2008
WIG-DEVELOPERS	15.06.2007
WIG-ENERGY	31.12.2009
WIG-IT	31.12.1998
WIG-MEDIA	31.12.2004
WIG-OIL & GAS	31.12.2005
WIG-FOOD	31.12.1998
WIG-BASIC MATERIALS	31.12.2010
WIG-TELECOM	31.12.1998

Source: own study based on the data from: sector indices [2015], the Warsaw Stock Exchange [http://www.gpw.pl/indeksy_en#sectorbased].

Therefore, by taking such assumptions it is reasonable to investigate the level of efficiency of these indexes which serve as "portfolios of stocks". Portfolios with higher level of efficiency have relatively more favorable relation between profitability and risk, so they are characterized by lower standard deviation with yield on the level of other portfolios yield. Furthermore, with the same level of standard deviation, portfolios with higher level of efficiency have higher rates of return.

When it comes to efficiency ratios, there have been 5 ratios selected: Sharpe ratio, Treynor ratio, Jensen's alpha, Information ratio and Sortino ratio. They are widely used across the financial world to assess performance of investment funds, hedge funds and portfolios of stocks.It is important to add that the risk free rate of return R_f constitutes the nominal yield of two-year bonds issued by the Polish government. For each year the series of bonds issued in the given year has been chosen. For calculation purposes the average daily risk-free rate of return has been utilized. Moreover, it has been assumed that returns of WIG would play a role of a market rate of return R_m. This index embraces all companies quoted on the Warsaw Stock Exchange. As a result it is believed to be an accurate estimator of market rates of return.

Stage 2 and 3 has been devoted to the calculationof above mentioned ratios as well as measures needed to estimate them. There have been calculated the following measures: rate of return, excess return, standard deviation, semi-standard deviation, beta coefficient, excess return, standard deviation of excess return and correlation between daily rates of return of indexes and daily rates of return of WIG. Beta coefficient has been computed with the use of the regression model. The formula which served to estimate its value is derived from Capital Asset Pricing Model (CAPM). This formula is as follows:

$$R = R_f + \beta * (R_m - R_f),$$

where: R = expected rate of return of a security, R_f = rate of return of a risk-free assets, R_m = market rate of return, ß = beta coefficient of a particular security.

Above-mentioned formula is the regression equation [Welfe 2003, p. 30; Osińska 2006, pp. 103-104]. Beta coefficient and the parameters of this equation can be estimated by the useof Ordinary Least Squares (OLS) which is a popular statistical method [Guzik, Jurek 2003, pp. 33-40].

Rates of return and standard deviations have been calculated on the daily basis. Pearson's correlation coefficient, known as R, served as a tool to assess the direction and the strength of linear relationship between WIG and each of the sector indexes. Rate of return served as a variable to count all of the before-mentioned efficiency measures. However, in the case of Information ratio and Sortino ratio it is in form of excess return. Risk factors: standard deviation and beta are utilized in Sharpe ratio and Treynor ratio consecutively as well as the Jensen's alpha.

Stage 4 of the research consists of the creation of rankings of indexes. First of all, rankings for each year and each ratio have been created. So in total, 30 rankings

have been prepared for years 2008-2013 (5 rankings per year as there are 5 efficiency indicators). The methodology of rankings was as follows: together with a rising value of efficiency ratio, the position in a table (ranking) also rises. It is based on the assumption that higher values of these measures indicate higher efficiency of an investment. To all positions the number of points has been assigned. The lower the number of points is, the better is the position of an index in a ranking. Exemplarily, for the second place in the ranking two points are allocated. In a given year, all the points in all rankings have been summed up which has created the yearly rankings. The position of all the indices in the tables have been set on the grounds of points achieved. Notwithstanding this, points served as an indicator which index was the most efficient in a given year. Finally, the positions of indices were converted for numbers of position in the table (since then, this number has been treated as points). So, if WIG-TELECOM was on the first place in 2008, it received 1 point. However, 1 year later it was on the third position and it received 3 points (see: appendix 1). The results from these tables have also been counted and put together with rankings from other years. In the end, it contributed to the final ranking (table) which allows selecting the most and the least efficient indexes throughout 2008-2013. As a consequence, it shows the general efficiency of indices. To give an example, WIG-BANKS was from 2008 to 2013 respectively on the following places in the ranking: 2,5,5,6,4,4, so it received 26 points (the sum of number of places in yearly rankings).

The next subsection of this article has been devoted to stage 5 that consists of the process of comparing and contrasting outcomes of the calculation.

5. Results of the research

Research stages described in the previous subsection led to two final stages (stage 5 and 6) – the comparison of values of efficiency ratios and ultimate conclusions. It is important to note that the final conclusions are based mainly on the outcomes of efficiency ratios computation. In order to count them, at first the standard deviation and beta coefficient had to be estimated. For each portfolio these two figures serve as a risk measure. Standard deviation embraces the entire risk connected with investment in a concrete index. So, it covers both market and specific risk. On the contrary to this, beta coefficient measures systematic risk only. Table 2 presents the final results of efficiency ratios comparison − values of Sharpe ratio, Treynor ratio, Jensen's alpha, Information ratio and Sortino ratio for all studied sector indexes in 2013. It includes efficiency measures counted on the basis of figures embraced in appendix 2. Data of the same statistical categories for other years (concerning figures necessary to computevalues of efficiency ratios) have been also prepared in the study.The information ratio and Jensen's alpha were not calculated for WIG due to the lack of the proper market benchmark for the main market index. The exemplary analysis of table 2 makes it clear that indications of consecutive efficiency measures are very consistent. In general, an index which has been negatively assessed by one

measure, was granted also poor place in the ranking by another measure. For instance, WIG-CONSTRUCTION in 2013 won 3 ratios rankings and in 2 others was in the second place. Contrarily, WIG-BASIC MATERIALS took the last place in 4 rankings. In one ranking it took penultimate position. The consistency of indications was true also for indexes from the middle of a stake. For example,WIG-TELECOM took seventh place in all 5 rankings. Owing to the fact that indications of 5 ratios are quite similar, the outcomes of the research seem to be reliable. Tables with values of ratios from other years lead to likewise deductions. Table 3 presents values of Pearson's correlation coefficient of separate indices in years 2008-2013. All indices in every year were characterized by the positive correlation with the main index on the Polish capital market – WIG. There is no wonder that there was no negative correlation due to the fact that price fluctuations of the whole market and the separate stocks are usually crucially linked. So, they move, in general, in the same direction. The highest correlation was between WIG20 and WIG. It oscillated around 98% in the period studied. Amongst sector indexes the highest correlation appeared in the case of WIG-BANKS – more than 90% till 2011 and slightly less than 90% in other years. In 2013 there was mainly mediocre correlation between WIG and index sectors. There is one distinction from this rule, namely, WIG-TELECOM which correlation was weak in 2013. Generally, the correlation between WIG and all sector indexes in 2008 was by far higher than in other years, especially in 2013. The trend in the correlation was downward in the studied period. For all indices, the correlation was higher in 2008 than in 2013.

Presumably, such a relation was caused by the sharp decline in the market in 2008 when the majority of stocks lost in value severely. On the other hand, in 2013 the horizontal trend prevailed and there were no such extreme circumstances, so shares tended to move rather more in their own way.Table 4 presents beta coefficient of separate indices in the years 2008-2013. It provides the piece of information about the defensiveness and aggressiveness of indexes. To aggressive indexes (with beta above 1) belong: WIG-BANKS, WIG-CHEMICALS, WIG-OIL&GAS, WIG-BASIC MATERIALS AND WIG20. However, the majority of indices was rather defensive (beta below 1 but higher than zero). To this group belong: WIG-CONSTRUCTION, WIG-DEVELOPERS, WIG-ENERGY, WIG-IT, WIG-MEDIA, WIG-FOOD and WIG-TELECOM. Throughout the 6 studied years only 3 indices had high value of beta (above 1) in each year: WIG-BANKS, WIG20 AND WIG-OIL&GAS. Some indexes such as WIG-CONSTRUCTION, WIG-ENERGY, WIG-IT, WIG-MEDIA, WIG-FOOD and WIG-TELECOM had only below 1 value of beta. The rest of the group was not characterized by any clear tendency in terms of beta – in some years its value exceeded 1, but not always. The data concerning beta coefficient indicates that the majority of indexes during a bullish market would not achieve any outstanding profits in comparison with WIG.

Table 5 presents final points in portfolio rankings. The methodology of rankings creation has been described in the previous subsection. The analysis of this table is

Table 2. The values of efficiency ratios in 2013

Sectorindex	Sharpe ratio	Treynor ratio	Jensen ratio	Information ratio	Sortino ratio
WIG-BANKS	6.258%	0.069%	0.121%	8.155%	9.182%
WIG-CONSTRUCTION	9.433%	0.175%	0.173%	8.085%	14.154%
WIG-CHEMICALS	4.564%	0.082%	0.139%	3.671%	6.574%
WIG-DEVELOPERS	0.700%	0.011%	–0.005%	–1.994%	0.977%
WIG-ENERGY	–2.348%	–0.034%	–0.090%	–5.697%	–3.229%
WIG-IT	6.811%	0.120%	0.110%	5.027%	9.825%
WIG-MEDIA	7.380%	0.125%	0.186%	6.806%	11.080%
WIG-OIL & GAS	–2.568%	–0.032%	–0.123%	–6.494%	–3.560%
WIG-FOOD	–3.460%	–0.065%	–0.105%	–6.103%	–4.548%
WIG-BASIC MATERIALS	–9.014%	–0.113%	–0.390%	–15.791%	–11.451%
WIG-TELECOM	–0.908%	–0.025%	–0.059%	–2.220%	–1.053%
WIG	2.747%	0.026%			2.916%
WIG 20	–2.955%	–0.029%	–0.100%	–23.044%	–4.042%

Source: own study based on the research.

Table 3. Pearson's correlation coefficient of separate indices with WIG in years 2008-2013

Sectorindex	2008	2009	2010	2011	2012	2013
WIG-BANKS	95.6%	94.9%	93.9%	92.3%	88.9%	87.4%
WIG-CONSTRUCTION	84.9%	83.8%	81.5%	67.2%	51.7%	51.9%
WIG-CHEMICALS	77.1%	64.5%	63.3%	69.2%	52.3%	53.7%
WIG-DEVELOPERS	81.1%	78.6%	73.2%	76.4%	64.9%	61.4%
WIG-ENERGY			65.3%	81.4%	67.0%	66.8%
WIG-IT	74.3%	72.6%	64.9%	76.6%	53.4%	54.8%
WIG-MEDIA	76.2%	74.5%	71.7%	65.5%	58.1%	56.8%
WIG-OIL & GAS	80.5%	83.6%	87.5%	87.9%	69.8%	77.0%
WIG-FOOD	65.4%	50.7%	42.6%	66.9%	47.6%	51.4%
WIG-BASIC MATERIALS				81.3%	82.1%	76.7%
WIG-TELECOM	69.8%	57.0%	56.1%	47.6%	37.4%	35.1%
WIG 20	98.6%	98.5%	98.5%	98.3%	97.4%	97.9%

Source: own study based on the research.

Table 4. Beta coefficient of separate indices in years 2008-2013

Sectorindex	2008	2009	2010	2011	**2012**	**2013**
WIG-BANKS	1.35	1.53	1.31	1.22	1.28	1.05
WIG-CONSTRUCTION	0.87	0.67	0.74	0.72	0.90	0.65
WIG-CHEMICALS	0.86	0.70	0.76	1.12	0.78	1.01
WIG-DEVELOPERS	1.25	0.99	0.86	0.91	1.03	0.72
WIG-ENERGY			0.57	0.87	0.85	0.97
WIG-IT	0.68	0.65	0.73	0.85	0.70	0.64
WIG-MEDIA	0.79	0.75	0.86	0.71	0.85	0.89
WIG-OIL & GAS	1.02	1.13	1.24	1.16	1.07	1.25
WIG-FOOD	0.61	0.51	0.57	0.76	0.76	0.75
WIG-BASIC MATERIALS				1.39	1.49	1.34
WIG-TELECOM	0.70	0.55	0.64	0.56	0.52	0.82
WIG 20	1.18	1.21	1.20	1.09	1.15	1.13

* The independent variable is WIG

Source: own study based on the research.

the core essence of this research. Sectors have been assigned to places by the last column – the average ranking points. They have been sorted in the descending order. These final results have been based on the results of appendix 1 which embraces portfolio rankings for subsequent years. As mentioned earlier, appendix 2 presents statistical categories and efficiency ratios calculated on the data from 2013.

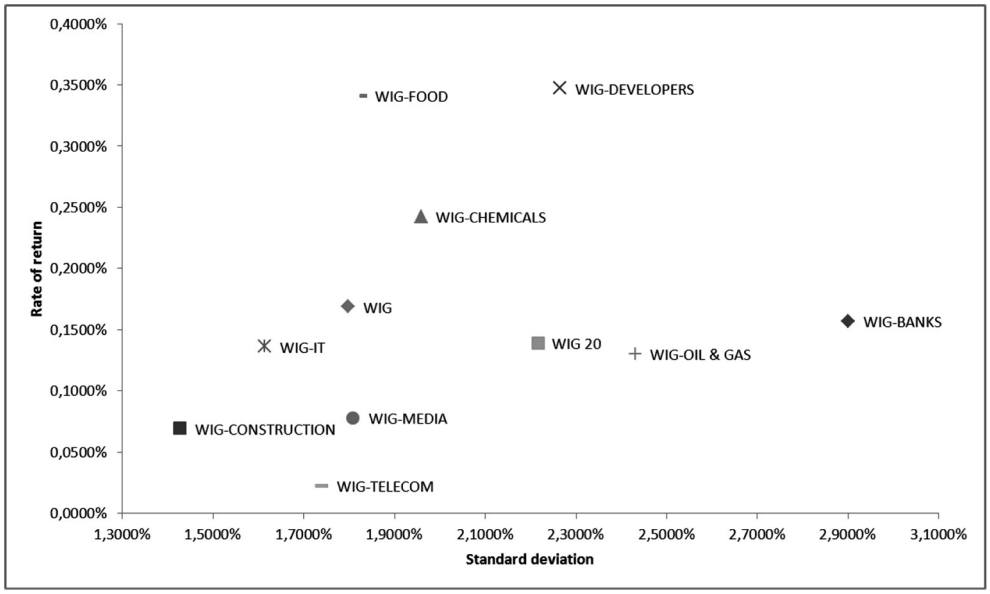

Figure 2. The map of risk and return in 2009

Source: own study based on the research.

The term "statistical categories" embraces the rate of return, standard deviation, beta coefficient, excess return, standard deviation of excess return, semi standard deviation and Pearson's correlation of a given index with WIG. Computations have been realized separately for each index. Appendix 3 presents rankings of indexes in terms of their yearly profitability. Appendix 4 shows the classification of portfolios in terms of their risk year by year. It seems that places in the ranking are unstable both in appendix 3 and 4.

Turning back to table 5, it is important to stress that the first place in the ranking is occupied by WIG-CHEMICALS. Other places from 2 to 5 are occupied by WIG-BANKS, WIG-OIL&GAS, WIG-MEDIA AND WIG-IT. Then, it should be assumed that stocks included in above-listed indexes were most efficient within the studied time frame. Consequently, these stocks posed relatively little risk with reasonably high rate of return. On the contrary to this, on the bottom of the table are WIG-CONSTRUCTION, WIG-DEVELOPERS AND WIG-ENERGY.

They presented the highest average ranking points. Within 6 years of the time frame these 3 indexes were the worst in terms of efficiency. It means they offered comparatively low rate of return with fairly high risk. At the same time, it must be stated that data for 2 indexes: WIG-ENERGY and WIG-BASIC MATERIALS has been prepared on the basis of incomplete number of years because their first publication fell on 2009 and 2010 consecutively. Yet, all the figures in the table are comparable due to the average ranking points calculated. The differences between the top and bottom places are significant – values vary from 3,67 average points in the case of WIG-CHEMICALS to more than 8 in the case of WIG-CONSTRUCTION.

It leads to the conclusion that in the period studied there were some portfolios of companies which were by far more efficient than others. The worst places of developers and construction companies in the ranking may be explained by very difficult economic situation of firms from these industries after the global financial crisis from 2007-2009. These were amongst sectors which mostly suffered from the economic decline.

Figure 2 presents the exemplary relation between risk (standard deviation) and the rate of return of indexes (treated as portfolios) in 2009. It is the graphical evidence of figures listed previously. WIG-FOOD was the most efficient index in 2009. It had a relatively high rate of return with comparatively low standard deviation of returns. Its daily average rate of return amounted to 0,34% (the second highest in the group) and its standard deviation oscillated around 1,83% (middle position in the ranking). As a whole, relatively high return and low risk contributed to the first place of WIG-FOOD in the efficiency ranking.

Table 5. The final results of rankings

Place in the ranking	Sector index	Sum of the ranking points	The average ranking points
1	WIG-CHEMICALS	22	3.67
2	WIG-BANKS	26	4.33
3	WIG-OIL & GAS	31	5.17
4	WIG-MEDIA	35	5.83
5	WIG-IT	36	6.00
6	WIG-TELECOM	38	6.33
6	WIG 20	38	6.33
8	WIG-FOOD	40	6.67
9	WIG-BASIC MATERIALS	21	7.00
10	WIG-ENERGY	29	7.25
11	WIG-DEVELOPERS	44	7.33
12	WIG-CONSTRUCTION	50	8.33

Source: own study based on the research.

The holistic comparison of efficiency of WIG and other sectors in the form of ranking was not conducted owing to the fact that values of information ratio had not been computedfor WIG (in order to count Information ratio for WIG the benchmark rate of return in the formula would be doubled; in this case another benchmark rate of return of the capital market should be found). The exemplary contradiction can be made in terms of the most popular Sharpe ratio. The values of this indicator in 2013 for all indexes have been embraced in table 2. In 2008 WIG was one of the least efficient stock market indexes. However, in 2009 the situation changed dramatically – WIG took the fourth top place in terms of efficiency measured by Sharpe ratio. Years 2010, 2011 and 2013 set WIG in the middle of the stake. Relatively good performance of WIG was in 2012 when an index was on the third place in terms of efficiency. This study proves that throughout the years, WIG index was not the most efficient one. Thus,it is possible to choose a portfolio, even built with companies which are members of only one sector index, which is comparatively or even more efficient than WIG.So it is important to emphasize that the aim of this article has been realized.

6. Conclusions

The research conducted in the article indicated that in the given period from 2008 to 2013 sector indexes which were by far better investment goals than othersoccurredon the Warsaw Stock Exchange (WSE). Each index in the research has been treated as a portfolio of stocks which investors might buy or sell. The study emphasized that in terms of the relationship between risk and return efficient and non-efficient indexesactually appeared on the WSE. It is evident that stocks from different indices present various efficiency level measured by Information ratio and ratios of Sharpe, Treynor, Jensen and Sortino. Some indexes were efficient (comparing them to other indexes) and this tendency was quite stable in time. Therefore, the research hypothesis can be verified positively. It appeared that the ranking method pointed out sector indices which were more efficient than others in the years 2008-2013.

Yet, it would be the motive for the next researches with the aim to check if this stable tendency also occurred in different time frames, namely, what is the price action of stock in different period (regarding their risk at the same time). Another thing worth recommending is the application of statistical tests in order to measure the stability of classification of indices in consecutive years. The scope of the research would be also extended, e.g. the NewConnect may also be covered. It is the platform for smaller and less liquid companies than those listed on the main market. Notwithstanding this, it is very interesting to get to know what the level of efficiency of NewConnect indices in comparison with other indexesis. The field of research could be also broadened by adding the analysis of indexes from well-developed stock exchanges such as Dow Jones, DAX, FTSE or CAC40. To give more evidence

on the stability of relative efficiency measures in time, the research period should be prolonged. If it embraces more than 6 years, the results will be more reliable.

It is important to emphasize that the research conducted in this article realized its purpose. The conclusions are of a great practical meaning – they can be potentially utilized by investors in practice to select companies, branches or portfolios that are more efficient than others. Such an approach would lead to the higher efficiency of investments on a stock market.

Appendix 1. The position of consecutive indices in the yearly ranking

	Index					
No.	2008	2009	2010	2011	2012	2013
1	WIG-TELECOM	WIG-FOOD	WIG-CHEMICALS	WIG-CHEMICALS	WIG-BASIC MATERIALS	WIG-CONSTRUCTION
2	WIG-BANKS	WIG-DEVELOPERS	WIG-FOOD	WIG-TELECOM	WIG-CHEMICALS	WIG-MEDIA
3	WIG-OIL & GAS	WIG-CHEMICALS	WIG-MEDIA	WIG-ENERGY	WIG-OIL & GAS	WIG-IT
4	WIG 20	WIG-IT	WIG-OIL & GAS	WIG-IT	WIG-BANKS	WIG-BANKS
5	WIG-MEDIA	WIG-BANKS	WIG-BANKS	WIG-OIL & GAS	WIG 20	WIG-CHEMICALS
6	WIG-IT	WIG 20	WIG 20	WIG-BANKS	WIG-DEVELOPERS	WIG-DEVELOPERS
7	WIG--CONSTRUCTION	WIG-OIL & GAS	WIG-TELECOM	WIG 20	WIG-MEDIA	WIG-TELECOM
8	WIG-DEVELOPERS	WIG-MEDIA	WIG-ENERGY	WIG-BASIC MATERIALS	WIG-FOOD	WIG-ENERGY
9	WIG-FOOD	WIG-CONSTRUCTION	WIG--CONSTRUCTION	WIG-FOOD	WIG-IT	WIG-OIL & GAS
10	WIG-CHEMICALS	WIG-TELECOM	WIG-IT	WIG-MEDIA	WIG-ENERGY	WIG 20
11			WIG-DEVELOPERS	WIG--DEVELOPERS	WIG-TELECOM	WIG-FOOD
12				WIG--CONSTRUCTION	WIG-CONSTRUCTION	WIG-BASIC MATERIALS

Source: own study based on the research.

Appendix 2. Statistical categories of indexes in 2013

Sectorindex	Rate of return	Standard deviation	Beta coefficient	Excess return	Standard deviation of excess return	Semi standard deviation	Pearson'scorrelation with WIG
WIG-BANKS	0.0823%	1.1613%	1.0527	0.0462%	0.5665%	0.7916%	87.4049%
WIG-CONSTRUCTION	0.1243%	1.2164%	0.6549	0.0883%	1.0916%	0.8107%	51.9103%
WIG-CHEMICALS	0.0919%	1.8043%	1.0053	0.0559%	1.5219%	1.2527%	53.7179%
WIG-DEVELOPERS	0.0175%	1.1293%	0.7188	–0.0186%	0.9320%	0.8089%	61.3683%
WIG-ENERGY	–0.0233%	1.3999%	0.9703	–0.0594%	1.0418%	1.0179%	66.8253%
WIG-IT	0.0868%	1.1331%	0.6438	0.0507%	1.0083%	0.7855%	54.7783%
WIG-MEDIA	0.1208%	1.5064%	0.8877	0.0847%	1.2444%	1.0035%	56.8172%
WIG-OIL & GAS	–0.0305%	1.5622%	1.2469	–0.0666%	1.0255%	1.1269%	76.9609%
WIG-FOOD	–0.0391%	1.4087%	0.7503	–0.0752%	1.2325%	1.0717%	51.3510%
WIG-BASIC MATERIALS	–0.1421%	1.6829%	1.3385	–0.1782%	1.1284%	1.3248%	76.6863%
WIG-TELECOM	–0.0109%	2.2499%	0.8188	–0.0469%	2.1140%	1.9412%	35.0907%
WIG	0.0361%	0.9642%	1.0000			0.6921%	100.0000%
WIG 20	–0.0233%	1.1135%	1.1311	–0.0594%	0.2577%	0.8143%	97.9447%

Source: own study based on the research.

Appendix 3. Ranking of the rates of return of indices in 2008-2013

No.	2008	2009	2010	2011	2012	2013
1	WIG-TELECOM	WIG-DEVELOPERS	WIG-CHEMICALS	WIG-CHEMICALS	WIG-BASIC MATERIALS	WIG--CONSTRUCTION
2	WIG-BANKS	WIG-FOOD	WIG-FOOD	WIG-TELECOM	WIG-CHEMICALS	WIG-MEDIA
3	WIG-OIL & GAS	WIG-CHEMICALS	WIG-OIL & GAS	WIG-ENERGY	WIG-OIL & GAS	WIG-CHEMICALS
4	WIG 20	WIG-BANKS	WIG-MEDIA	WIG-IT	WIG-BANKS	WIG-IT
5	WIG-IT	WIG 20	WIG-BANKS	WIG-OIL & GAS	WIG 20	WIG-BANKS
6	WIG-MEDIA	WIG-IT	WIG 20	WIG-BANKS	WIG-DEVELOPERS	WIG-DEVELOPERS
7	WIG-CONSTRUCTION	WIG-OIL & GAS	WIG-TELECOM	WIG 20	WIG-MEDIA	WIG-TELECOM
8	WIG-FOOD	WIG-MEDIA	WIG-ENERGY	WIG-FOOD	WIG-FOOD	WIG-ENERGY
9	WIG-DEVELOPERS	WIG--CONSTRUCTION	WIG--CONSTRUCTION	WIG-BASIC MATERIALS	WIG-IT	WIG 20
10	WIG-CHEMICALS	WIG-TELECOM	WIG-IT	WIG-MEDIA	WIG-ENERGY	WIG-OIL & GAS
11			WIG-DEVELOPERS	WIG--DEVELOPERS	WIG-TELECOM	WIG-FOOD
12				WIG--CONSTRUCTION	WIG--CONSTRUCTION	WIG-BASIC MATERIALS

Source: own study based on the research.

Appendix 4. Ranking of the standard deviation of indices in 2008-2013

No.	2008	2009	2010	2011	2012	2013
1	WIG-IT	WIG--CONSTRUCTION	WIG-ENERGY	WIG-CONSTRUCTION	WIG 20	WIG 20
2	WIG-FOOD	WIG-IT	WIG--CONSTRUCTION	WIG-ENERGY	WIG-ENERGY	WIG--DEVELOPERS
3	WIG-TELECOM	WIG-TELECOM	WIG-IT	WIG-MEDIA	WIG-IT	WIG-IT
4	WIG--CONSTRUCTION	WIG-MEDIA	WIG-TELECOM	WIG 20	WIG-TELECOM	WIG-BANKS
5	WIG-MEDIA	WIG-FOOD	WIG-DEVELOPERS	WIG-IT	WIG-BANKS	WIG--CONSTRUCTION
6	WIG 20	WIG-CHEMICALS	WIG-MEDIA	WIG-FOOD	WIG-MEDIA	WIG-ENERGY
7	WIG-OIL & GAS	WIG 20	WIG-CHEMICALS	WIG-TELECOM	WIG-CHEMICALS	WIG-FOOD
8	WIG-BANKS	WIG-DEVELOPERS	WIG 20	WIG-DEVELOPERS	WIG-OIL & GAS	WIG-MEDIA
9	WIG-DEVELOPERS	WIG-OIL & GAS	WIG-FOOD	WIG-BANKS	WIG--DEVELOPERS	WIG-OIL & GAS
10	WIG-CHEMICALS	WIG-BANKS	WIG-BANKS	WIG-OIL & GAS	WIG-FOOD	WIG-BASIC MATERIALS
11			WIG-OIL & GAS	WIG-CHEMICALS	WIG--CONSTRUCTION	WIG-CHEMICALS
12				WIG-BASIC MATERIALS	WIG-BASIC MATERIALS	WIG-TELECOM

Source: own study based on the research.

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EFEKTYWNOŚĆ INDEKSÓW GIEŁDOWYCH W POLSCE – UJĘCIE EMPIRYCZNE

Streszczenie: Inwestorzy na rynku kapitałowym oceniają wyniki portfeli pod względem osiąganej stopy zwrotu. Zazwyczaj analizują również ryzyko związane z daną inwestycją. Relacja między tymi dwiema kategoriami może służyć do oceny różnorodnych aktywów inwestycyjnych w kontekście pojęcia efektywności portfeli według H. Markowitza. Im korzystniejsza jest relacja zysku do ryzyka, tym bardziej efektywny jest portfel. W artykule przeprowadzono badanie empiryczne efektywności indeksów sektorowych notowanych na Giełdzie Papierów Wartościowych w Warszawie i ich kształtowania się w latach 2008-2013. W badaniu porównano 11 indeksów sektorowych, WIG20 i WIG. Głównym zagadnieniem artykułu jest praktyczny opis oraz wykorzystanie miar efektywności portfeli inwestycyjnych, takich jak wskaźnik Sharpe'a, alfa Jensena, wskaźnik Treynora, wskaźnik Sortino oraz Information Ratio. Obliczono również współczynnik korelacji Pearsona oraz współczynnik beta, którego wartość oszacowano na podstawie modelu regresji liniowej. Celem artykułu jest wskazanie najbardziej efektywnych sektorowych indeksów giełdowych (traktowanych jako potencjalne portfele, w które inwestor może zainwestować, odwzorowując skład indeksu) i porównanie ich efektywności z indeksem WIG. Przeprowadzono analizę porównawczą wyselekcjonowanych wskaźników efektywności portfeli. Rezultaty badania zaprezentowano w formie rankingu, na podstawie którego wskazano najbardziej efektywne portfele, mające najkorzystniejszą relację osiągniętej stopy zwrotu i ryzyka. Takie podejście jest pomocne w wyselekcjonowaniu potencjalnie najbardziej efektywnych sektorów i grup akcji spółek notowanych na rynku kapitałowym.

Słowa kluczowe: portfele efektywne, wskaźnik Sharpe'a, wskaźnik Treynora, alfa Jensena, wskaźnik Sortino.