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DEGREE OF CONVERGENCE OF THE EFFICIENCY OF THE POLISH EQUITY INVESTMENT FUNDS OBTAINED WITH MEASURES BASED ON THE SHARPE RATIO

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Abstract

Long-term persistence of low interest rates and a decline in attractiveness of investing in low-interest bank deposits generate additional demand for investments in investment funds. In such a situation, it is expected to have widespread use of the investment efficiency measures which take into account not only return, but risk level. The study examines eight measures of efficiency based on the Sharpe ratio. The study uses monthly data for 22 active equity funds over the period 2005-2015. It was found that the majority of funds were more efficient than the market in periods of moderate economic growth and less effective in the period of strong growth on the capital market. The most efficient funds retain high efficiency in all phases of the economic cycle. The efficiency values obtained using indicators: Shape, Treynor, Jensen, Sortino, Omega, Sharpe-Israelsen and IR were strongly correlated, while values of the UPR indicator were significantly different from the other results.

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Introduction

The low interest rate environment and low rates on bank deposits foster the growth of demand for investments in investment funds. In consequence, a growing demand appears for creation and a broader use of reliable measures evaluating performance of investment funds. Dealing with individual customers, fund managers usually present the results of their operations using historical rates of return. In this way, they want to prove their ability to generate high returns. They ignore or do not pay sufficient attention to the presentation of the level of risk associated with a particular investment. If the risk materializes, this information asymmetry becomes a source of conflict between investors and investment firms.

It should be noted, however, that the process of risk measurement is not explicit and well-defined, as is in the case of the rate of return on investment. There is no strict definition of risk and its precise measurement. It is expected, therefore, that the proper measure of investment performance should take into account both changes in the value of investments, as well as the associated risks. Principles of construction of such measures should be clear and their interpretation relatively straightforward.

A classic measure of investment performance is the Sharpe ratio (Sharpe, 1966, 1975). The indicator relates a surplus of investment return over the risk-free investment to the level of risk which is associated with a particular investment. Based on this principle, there have been proposed many measures of assessing the efficiency of investments. Their principles contain different ways of representing or calculating effects of the investment in the sense of the surplus rate of return on the investment over the baseline or expected level of rate of return. Additionally, these measures in different ways estimate the level of risk associated with a particular investment.

Studies analyzing efficiency of investment funds more frequently use measures constructed on the basis of the Sharpe ratio. Karpio and Żebrowska-Suchodolska (2013) to review such measures and apply them to assess the activities of investment funds in the period 2003-2011. The results indicate the presence of certain differences in the efficiency assessment obtained with the use of various efficiency measures. However they state that all applied measures enabled the user to clearly divide the sample of analyzed funds into two groups of more and less efficient funds. In turn, Pedersen and Rudholm-Alfvin (2003) present several measures in principle derived from the Sharpe ratio and examine their suitability for different asset classes. They also point to the existence of some differences in the obtained results with these measures.

On the other hand, Eling's study (2008) based on the comparison of measurements of fund efficiency using several measures (including indicators: Sharpe, Omega, Sortino, UPR, Calmar, Kappa 3, and Sterling) finds that the value of a fund`s efficiency does not depend on the applied measure. In this research he examined about 34,000 funds in the period 1995-2007. Additionally, he notes that the most correct results were obtained using a classic Sharpe ratio.

The aim of this article is to present the ideas and characteristics of eight measures of investment fund efficiency and then to test the correctness of efficiency assessments achieved with these measures. The study covers 22 funds with the majority of equity in the portfolio in Poland in the years 2015-2015. This period covers the different phases of the economic cycle, i.e.: upward – the years 2005-2007, the economic downturn – 2008-2011 and the moderate growth period – 2012-2015. Eight measures based on the Sharpe indicator were applied to the study i.e. ratios of: Sharpe, Treynor, Jensen (Jensen's alpha), Sortino, Sharpe-Israelsen, Omega, potential excess return (UPR) and information (IR). The efficiency was measured for the entire period and for three sub-periods covering the years: 2005-2007, 2008-2011 and 2012-2015.

In the next step, the correlation between the results of individual measures was assessed for each of the analyzed periods. The monthly data on values of the fund shares come from the Chamber of Fund and Asset Management (IZFiA). Values of the WIG index and IRS 1Y were obtained from the Bloomberg database.

The remainder of the paper is structured as follows: the next chapter presents the ideas of classic and alternative efficiency measures, later – values of efficiency of selected investment funds and comparison of the results of these metrics are presented. Finally, conclusions are summarized.

The classic measures of the efficiency of investment funds

The efficiency of investments can be treated as the profitability of the investment adjusted for the size of the risk involved. Typically, it compares rates of return on investment with the return on the benchmark, which can be represented by a group of similar financial instruments, the market a part of which is the investment itself or the risk-free instrument. In some cases, the reference point is considered the rate of return expected by the investor.

The profitability of investments made in the fund shares at time t is counted as a logarithmic rate of return rt defined by the formula (Witkowska, 2009):

$$r_t = \ln(\frac{p_t}{p_{t-1}}) \quad (1)$$

where p_t is the value of share of the investment fund in time *t* (quarter, month, day, etc.).

In the classic efficiency indicators the level of risk is evaluated using the standard deviation of the distribution of rates return σ(r):

$$\sigma(r) = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(r_t - \bar{r})^2} \quad (2)$$

where *T* is the total investment period,

$\bar{r}$ = expected (average) rate of return for the entire investment period *T*.

Another measure of risk is a β coefficient. It indicates how the fund`s rate of return differs from the profitability of the overall market (Czekaj, Woś & Żarnowski, 2001; Tarczyński, 1997, pp. 154-156). For the fund *i* the β coefficient is calculated according to the following formula:

$$\beta_i = \frac{\sum_{t=1}^{T}(r_{it}-\bar{r}_i)(r_{mt}-\bar{r}_m)}{\sum_{t=1}^{T}(r_{mt}-\bar{r}_m)^2} \quad (3)$$

where r_{it} and r_{mt} = rates of return of, respectively, fund *i* and the entire market (mostly represented by the main stock exchange index) in time *t*,

$\bar{r}_i$ and $\bar{r}_m$ represent, respectively, the average values of the rates of return of fund *i* and the entire market in the period *T*.

The Sharpe ratio is one of the basic measures of investment efficiency and was developed on the basis of an analysis of US equity funds. The concept is based on the observation that for each fund there is a linear relationship between the standard deviation and the average rate of return (Sharpe, 1966, 1975). This means that funds with higher average rates of return are characterized with a higher risk represented by the standard deviation of a fund's rates of return. Risk assessment by the standard deviation covers the overall risk of a given investment fund. Therefore the attractiveness of the investment depends on the sensitivity of the profits to the level of risk taken.

For the fund *i* the Sharpe ratio (WS_i) is calculated by the formula:

$$WS_i = \frac{\bar{r}_i - \bar{r}_f}{\sigma_i(r)}, \quad (4)$$

where $\bar{r}_i$ and $\bar{r}_f$ represent, respectively, the average rate of return on the fund *i* and the risk-free investment in the period *T*. The positive value of WS_i means that the fund performs better than the risk-free investment, and oppositely when WS_i is negative – the fund's results are below the risk-free rate of return.

On the basis of such a measure we can conclude that the investment is more attractive if, for the same amount of risk, it brings more excess return over the rate of the risk-free investment. This ratio is sometimes called the premium for volatility (Perez, 2012, pp. 146-147). The Sharpe ratio is mainly used for comparative analysis of homogeneous groups of portfolios, as well as in relation to a designated benchmark. Perez (2012) argues that this indicator has the best measurement characteristics when the financial market is in an upward trend. It is an appropriate tool to structure portfolios according to their effectiveness. Perez also indicates that it can less accurately estimate fund efficiency in periods of recession, when the market rates of return are lower than the rates of return of the risk-free investment, and the risk premium becomes negative.

The Treynor ratio is a measure designed on an idea similar to the Sharpe ratio, but it uses a different measure of risk, i.e. a β coefficient (Treynor, 1965). The β coefficient represents the systematic risk that is associated with the activities of the entire market which the investment managers are unable to diversify. The value of the Treynor ratio (WT_i) for the fund *i* is calculated by the following formula:

$$WT_i = \frac{\bar{r}_i - \bar{r}_f}{\beta_i} \quad (5)$$

where β_i = a beta coefficient representing systematic risk taken by the fund *i* in the investment period *T* (Kopciński, 2013).

Higher values of WT indicate that the investment is

more efficient. Sikora (2010)[1] indicates that the Treynor ratio can be, similarly to the Sharpe ratio, used to assess a particular group of funds, for example investing in an individual sector. Perez (2012) notes that for the purpose of testing fund performance the Treynor ratio is less frequently used than the Sharpe ratio.

The value of the WT indicator can be either positive or negative. However, negative values may come not only from a negative risk premium (when the value of the fund rate of return is lower than the risk-free rate), but also from the negative value of the β coefficient. This fact makes the results obtained with the Treynor ratio more volatile than the results gained using the Sharpe ratio.

The Jensen`s alpha index allows us to evaluate the efficiency of the investment fund management team and the effects of the selection of its portfolio components. The Jensen alpha index is a measure indicating the absolute benefits or lack of benefits from the investment. Kopciński (2013) believes that the index can be recommended for measurement of highly diversified funds. It combines values of rate of return on: a risk-free investment, the market portfolio and the tested investment fund, and also the level of risk taken by the fund.

For the fund i the Jensen alpha index (WJ_i) is calculated according to the formula:

$$WJ_i = (\bar{r}_i - \bar{r}_f) - \beta_i(\bar{r}_m - \bar{r}_f) \quad (6)$$

Higher values of WJ_i mean higher effectiveness of the fund`s management team (Ostrowska, 2003). A positive value of this indicator shows that the return on the fund's portfolio exceeds expectations estimated on the basis of the CAPM model. Negative values of the indicator WJ mean, however, that the fund (or financial investment) should not be chosen by the investor. The advantage of the WJ index is the ability to use it to assess efficiency of investment funds whose portfolios include stocks, i.e. equity, balanced, and stable growth funds.

Alternative measures of fund efficiency

Studies on investment fund performance have concluded with invention of a number of methods for measuring investment efficiency. Most of them base their idea on the Sharpe ratio. Some of them modified the representation of the profitability of investment activities, other the methods of measuring the risk associated with the investment. In the next section principles of the ratios: Sortino, Sharpe-Israelsen, Omega, IR and UPR will be presented.

The Sortino ratio is the relation of the surplus average return on investment $\bar{r}$ over the minimum required rate of return *m* to *σ(m)* – the level of risk associated with the investment. The rate *m* is the minimum rate of return acceptable by the investor. Investment risk is defined in an asymmetric way using semi-standard deviation of the rates of return distribution. The asymmetric measure takes into account only cases where the investment brings a lower rate of return than the minimum required rate of *m* (Kopciński, 2013, p. 318).

The Sortino ratio for the fund i is described by the following formula:

$$S_i = \frac{\bar{r}_i - m}{\sigma_i(m)} \quad (7)$$

where $\bar{r}_i$ stands for the historic average rate of return of the fund *i* in the investment period *T*.

Coefficient $\bar{\sigma}_i(m)$ is the risk measure of the fund *i* and is calculated according to the formula:

$$\bar{\sigma}_i(m) = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}[(r_{it} - m)^-]^2} \quad (8)$$

Function $(x)^-$ has the following characteristics: equals to *x* when $x \leq 0$ and equals to 0 when $x > 0$. This means that the risk measure takes into account only cases of loss compared to the minimum required rate of return.

The creators of the Omega ratio suggest that the rate *m* should be equal to the market portfolio rate of return, i.e. a portfolio representing the selected stock index, the main stock exchange index or should be equal to 0% (Sortino & Price, 1994). The indicator was introduced in the mid-1990s and is often used to assess the investment performance of hedge funds (Nguyen-Thi-Thanh, 2010). Increasingly, it is also used for the evaluation of traditional investment funds, including large portions of shares.

The Omega ratio is the relation of the average excess return over the threshold rate of return *L* to the average surplus of the rate *L* over the rate of return on investment (Shadwick & Keating, 2002). This indicator is a measure of the "spread" between the positive and negative deviations of rates from the value of the rate of return desired by the investor (Karpio & Żebrowska-Suchodolska, 2013).

1 Additionally, the Treynor ratio is used for the evaluation of investment efficiency by K. Jajuga and T. Jajuga (2005, pp.167–173), Tarczyński (1997, p.111–1140), Witkowska, Matuszewska and Kompa (2008, pp. 221–225).

The idea behind this measure is to divide rates of return on investments with the threshold rate *L* into two parts: an attractive and an unattractive rate for investors. The threshold rate of return (also known as a reference rate of return) is the value established by the investor. The advantage of using a threshold rate is to make the Omega ratio a more flexible instrument, which enables us to conduct the assessment under different assumed values of the threshold rate *L*. Such a concept of the measure helps to determine the results of the investment depending on different market conditions and investor expectations (Pichura, 2013). The Omega ratio is frequently used for measuring efficiency of hedge funds (Dyk van, Vuuren & Heymans, 2014).

The value of the Omega ratio $\Omega_i(L)$ for the fund *i* with the threshold rate *L* is calculated by the following formula:

$$\Omega_i(L) = \frac{\frac{1}{T-1}\sum_{t=1}^{T}\max\{r_{it}-L,0\}}{\frac{1}{T-1}\sum_{t=1}^{T}\max\{L-r_{it},0\}} \quad (9)$$

where *T* = total period of investment,

t = time (quarter, month, day, etc.),

r_{it} = rate of return of the fund *i* in the period *t*.

The information ratio (IR) indicates whether the risk taken by the management in relation to the benchmark is profitable. A higher level of the indicator IR means that with lower risk compared to the benchmark, the fund has achieved a better result. The index was proposed by Pedersen and Rudholm-Alfvina (2003). For the fund *i* the IR is calculated according to the formula:

$$IR_i = \frac{\bar{r}_i - \bar{r}_b}{\mathrm{TR}} \quad (10)$$

where $\bar{r}_i$ and $\bar{r}_b$ stand for, respectively, average value of the rate of return of the fund *i* and the benchmark rate for the investment period *T*.

The TR indicator is the standard deviation calculated according to the formula:

$$TR = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(r_{it} - r_{bt} - (\bar{r}_i - \bar{r}_b))^2} \quad (11)$$

where r_{it} and r_{bt} stand for, respectively, rate of return of the fund *i* and the benchmark rate for the period *t*.

When the rate $r_{b,t}$ equals zero the value of $\bar{r}_b$ also equals zero and the TR becomes a standard deviation and the IR – the Sharpe ratio with the risk-free rate of return 0%. When the market is volatile quite often the benchmark rate is set to 0%. These conditions indicate that the measure IR is more useful to investors during periods of stability on the capital market. Fund managers usually set the major stock indexes as benchmarks.

The Sharpe-Israelsen ratio is a modification of the IR measure. It has the form:

$$SI_i = \frac{\bar{r}_i - \bar{r}_b}{TR^{\pm 1}} \quad (12)$$

where the exponent at the TR indicator equals to 1 when $\bar{r}_i$ is greater than $\bar{r}_b$, and oppositely equals to -1 when it is smaller (Israelsen, 2005).

Evaluation of the efficiency of investment funds

The research sample consisted of 22 open equity investment funds operating in Poland in 2005-2015 (Table 1).

The analysis was performed using monthly data for four periods, i.e. years:

1) 2005-2007;
2) 2008-2011;
3) 2012-2015;
4) 2005-2015.

The rates of swap IRS 1Y served as the rates on risk-free assets. The market was represented with the WIG – the main index of the Warsaw Stock Exchange, which covers share prices of all listed companies. The value of the threshold rate of return L and the minimum required rate of return m was set at 0%. The study analyzed 2,902 observations, 792 in years 2005-2007 and 1,056 in each period of years 2008-2011 and 2012-2015.

In the first stage of research the values of monthly returns for the individual funds and for the market were calculated. Next, values of the mean and the standard deviation in four periods were assessed, as well as values of the average monthly rates on risk-free investments (Table 2).

The average values of rates of return on the fund shares indicate that investment funds often provided better results than investment in the stock market index WIG or investment in risk-free assets. Considering the entire market, equity funds performed the least well during the period of the strong growth on the Warsaw Stock Exchange in 2005-2007. At that time only two funds achieved higher rates of return than the WIG index. In other periods, funds rather achieved higher returns than the market. During the crisis period (years 2008-2011) it was the case of 9 funds, in the period of moderate growth (years 2012-2015) – all 22 funds, and for the entire analyzed period (years 2005-2015) - 18 funds. It

Table 1: List of investment funds covered with the study

Number of the fund	Name of the fund	Year of establishment
1	Allianz Akcji	2004
2	Arka BZ WBK Akcji Polskich	1998
3	Aviva Investors Polskich Akcji	2002
4	Aviva Investors Stabilnego Inwestowania	2002
5	BPH Akcji	1999
6	BPH Akcji Dynamicznych Spółek	2000
7	BPH Zrównoważony	1999
8	ING Akcji (obecnie NN Parasol)	1998
9	ING Akcji 2	2001
10	Investor Akcji Spółek Dywidendowych	1998
11	Investors Akcji (Investor Parasol)	1998
12	Investor Zrównoważony	1998
13	KBC Aktywny	2002
14	Legg Mason Akcji	1999
15	MetLife Akcji	2004
16	Novo Akcji	1998
17	Novo Zrównoważonego Wzrostu	1998
18	Pioneer Akcji Polskich	1995
19	Pioneer Zrównoważony	1992
20	PZU Akcji Krakowiak	1999
21	Skarbiec Akcja	1997
22	UniKorona Akcje	1996

Source: IZFiA

can be concluded that the investment managers usually perform better in periods characterized by the changing macroeconomic situation and changing conditions on the WSE.

Considering the rates of return on risk-free investment the performance of funds turned out to be the weakest in the period of the strongest impact of the financial crisis (2008-2011). At that time, none of the funds achieved a higher rate of return. The reverse situation occurred in the years of strong growth on the WSE – all 22 funds performed better than risk-free assets. In the years 2012-2015 the improving economic situation helped 10 funds to beat the risk-free investments. During the entire analyzed period 6 out 22 funds achieved average monthly rate of return better than the rate provided by the risk-free assets.

In the analyzed period funds achieved differentiated value of returns. Some of them remained in the group of the best performing funds throughout the entire period, among others, ING Akcji 2. Others performed well in the period of macroeconomic prosperity and much less during the economic downturn, including Arka BZ WBK Akcji Polskich, Legg Mason Akcji, and Aviva Investors Polskich Akcji.

Some funds, in turn, were characterized by an opposite cycle of rates of return, i.e. they achieved poor results in the periods of boom and the best during the economic slowdown. Aviva Investors Stabilnego Inwestowania is an example of such fund.

Throughout the entire analyzed period the highest rate of return were earned by ING Akcje 2, which in all macroeconomic conditions remained one of the top Polish equity funds. Next three funds in the ranking: Aviva Investors Polskich Akcji, Aviva Investors Stabilnego Inwestowania, or Legg Mason Akcji in different ways performed during periods of upward and downward turns of the Polish economy. Funds with the highest rates of return were characterized by investing mainly in shares

Table 2: Average and standard deviation of monthly rates of return of funds, the market and risk-free assets

Number of the fund	2005-2007		2008-2011		2012-2015		2005-2015	
	r	SD	r	SD	r	SD	r	SD
1	0,014	0,037	-0,006	0,069	-0,003	0,035	0	0,051
2	0,024	0,121	-0,013	0,08	0,002	0,035	0,003	0,083
3	0,02	0,055	-0,008	0,078	0,005	0,032	0,004	0,059
4	0,009	0,517	-0,001	0,031	0,004	0,014	0,004	0,268
5	0,019	0,05	-0,011	0,068	0,003	0,038	0,002	0,055
6	0,013	0,062	-0,017	0,077	0,008	0,036	0	0,061
7	0,012	0,029	-0,003	0,039	0,002	0,021	0,003	0,031
8	0,017	0,053	-0,011	0,07	0,005	0,036	0,002	0,056
9	0,019	0,049	-0,006	0,061	0,005	0,035	0,005	0,05
10	0,014	0,097	-0,009	0,09	0,002	0,033	0,001	0,077
11	0,018	0,052	-0,015	0,071	0,009	0,06	0,003	0,063
12	0,01	0,031	-0,006	0,047	0,008	0,025	0,004	0,036
13	0,009	0,033	-0,003	0,045	0,004	0,024	0,002	0,035
14	0,024	0,055	-0,007	0,067	0,001	0,035	0,005	0,055
15	0,019	0,054	-0,013	0,075	0	0,041	0	0,06
16	0,017	0,05	-0,005	0,132	-0,01	0,048	-0,001	0,089
17	0,011	0,031	-0,008	0,045	-0,004	0,034	-0,001	0,038
18	0,016	0,055	-0,02	0,09	-0,001	0,037	-0,004	0,067
19	0,009	0,032	-0,012	0,064	0,001	0,034	-0,002	0,047
20	0,017	0,049	-0,012	0,07	0	0,042	0	0,056
21	0,02	0,048	-0,009	0,082	0,002	0,481	0,003	0,293
22	0,018	0,061	-0,006	0,069	0,003	0,037	0,004	0,057
WIG	0,022	0,049	-0,008	0,07	-0,012	0,093	-0,001	0,076
IRS 1Y	0,004	---	0,004	---	0,002	---	0,003	---

Note: WIG – the WSE main index, IRS 1Y – rate of the swap, r – fund`s rate of return, SD – standard deviation of rates of return

Source: Own elaboration based on the data from IZFiA and Bloomberg

Table 3: Efficiency of investment funds in 2005-2015

Number of the fund	WS	WT	WJ	Sortino	Omega	IR	WS-I	UPR
1	-0.058	-0.008	-0.005	0.001	1.025	0.029	0.046	0.476
2	-0.009	-0.002	-0.003	0.004	1.110	0.046	0.033	0.453
3	0.013	0.002	-0.001	0.008	1.213	0.087	0.124	0.545
4	0.002	0.001	-0.002	0.002	1.166	0.019	0.010	0.140
5	-0.022	-0.003	-0.003	0.005	1.109	0.055	0.076	0.570
6	-0.055	-0.009	-0.005	0.000	1.000	0.019	0.019	0.484
7	-0.017	-0.002	-0.002	0.012	1.265	0.066	0.107	0.633
8	-0.017	-0.002	-0.003	0.005	1.121	0.059	0.081	0.554
9	0.027	0.004	0.000	0.012	1.278	0.097	0.139	0.634
10	-0.026	-0.005	-0.004	0.002	1.059	0.032	0.027	0.444

11	-0.006	-0.001	-0.002	0.006	1.138	0.061	0.098	0.527
12	0.005	0.001	-0.001	0.012	1.302	0.076	0.130	0.587
13	-0.026	-0.004	-0.002	0.009	1.204	0.059	0.099	0.579
14	0.022	0.003	-0.001	0.010	1.248	0.096	0.133	0.583
15	-0.054	-0.007	-0.005	0.000	1.008	0.024	0.033	0.498
16	-0.045	-0.009	-0.006	-0.001	0.978	0.008	0.017	0.425
17	-0.118	-0.017	-0.006	-0.003	0.923	0.003	0.005	0.459
18	-0.104	-0.014	-0.009	-0.006	0.860	-0.033	0.000	0.412
19	-0.111	-0.016	-0.007	-0.004	0.894	-0.008	0.000	0.418
20	-0.056	-0.007	-0.005	0.001	1.012	0.026	0.040	0.517
21	-0.002	-0.002	-0.002	0.001	1.073	0.014	0.113	0.199
22	0.012	0.002	-0.001	0.009	1.208	0.081	0.099	0.606

Note: WS – Sharpe ratio, WT – Treynor ratio, WJ – Jensen alpha index, Sortino –Sortino ratio, Omega – Omega ratio, IR –information ratio, WS-I – Sharpe-Israelsen ratio, UPR – upside potential ratio

Source: Own elaboration

Table 4: Investment fund efficiency ranking 2005-2015

Number of the fund	WS	WT	WJ	Sortino	Omega	IR	WS-I	UPR
1	19	17	15	14	15	13	12	14
2	9	8	11	11	11	11	14	16
3	3	3	2	7	5	3	4	9
4	6	5	6	12	8	16	19	22
5	12	12	12	9	12	10	11	7
6	17	18	16	17	18	17	17	13
7	10	9	7	1	3	6	6	2
8	11	10	13	10	10	8	10	8
9	1	1	1	2	2	1	1	1
10	13	14	14	13	14	12	16	17
11	8	7	8	8	9	7	9	10
12	5	6	3	3	1	5	3	4
13	14	13	9	5	7	9	7	6
14	2	2	4	4	4	2	2	5
15	16	15	17	18	17	15	15	12
16	15	19	19	19	19	19	18	18
17	22	22	20	20	20	20	20	15
18	20	20	22	22	22	22	21	20
19	21	21	21	21	21	21	22	19
20	18	16	18	15	16	14	13	11
21	7	11	10	16	13	18	5	21
22	4	4	5	6	6	4	8	3

Note: descriptions as in the table 3

Source: Own elaboration

Table 5: Degree of the Spearman correlation of investment fund efficiency measures 2005-2015

	WS	WT	WJ	Sortino	Omega	IR	WS_I	UPR
WS	1							
WT	0,88	1,00						
WJ	0,93	0,94	1,00					
Sortino	0,83	0,85	0,90	1,00				
Omega	0,89	0,91	0,95	0,97	1,00			
IR	0,84	0,86	0,90	0,95	0,92	1,00		
WS_J	0,79	0,80	0,86	0,88	0,86	0,87	1,00	
UPR	0,21	0,25	0,30	0,62	0,44	0,66	0,51	1,00

Note: descriptions as in Table 3, numbers in bold and underlined represent degrees of correlation, respectively, at 1% and 5% statistical significance
Source: Own elaboration

Table 6: Number of pairs of strong correlation between each fund efficiency measure in 2005-2015

Degree of correlation	WS	WT	WJ	Sortino	Omega	IR	WS_I	UPR
≥70%	6	6	6	6	6	6	6	0
≥50%	6	6	6	6	6	7	7	3

Note: descriptions as in Table 3
Source: Own elaboration

listed on the Warsaw Stock Exchange. This observation is consistent with the conclusions of the research by Witkowska (2009), who notes that results of most funds are closely related to the market in which they invest.

Based on the values of rates of return and risk measures, the efficiency was assessed for each fund using eight indicators, and next the performance ranks for the entire analyzed period, i.e. years 2005-2015 (Tables 3 and 4).

The analysis of the efficiency and ranks of individual funds show considerable convergence in assessments of funds' efficiency achieved with all eight measures. This relationship is significantly apparent for both the best and the worst performers. The first group includes funds: ING Akcje 2, Legg Mason Akcji, Aviva Investors Polskich Akcji and the second – funds: Pioneer Zrównoważony, Pioneer Akcji Polskich, Novo Zrównoważonego Wzrostu Novo Akcji.

To check the level of convergence in efficiency assessment obtained with various measures the correlation between them was tested (Tables 5 and 6).

The results of correlation between the values of efficiency indicators obtained for individual funds indicate that seven out of eight measures were strongly correlated. The UPR indicator was the only measure whose values, to a lesser extent, coincide with, or was different from, other measures.

Conclusions

Long-term persistence of low interest rates and a decline in attractiveness of investing in low-interest bank deposits generate additional demand for investments in investment funds. In such a situation, it is expected to have widespread use of the investment efficiency measures which take into account not only return, but risk level. The study examines eight measures of efficiency based on the Sharpe ratio and uses monthly data for 22 active equity funds over the period 2005-2015.

1) The majority of funds were more efficient than the market (represented by the WIG index) in periods of moderate economic growth, and less effective in the period of strong growth on the capital market.

2) The majority of funds got higher rates of return than the risk-free assets (represented by the IRS 1Y rate) during the periods of moderate and strong economic growth, however, during the economic slowdown none of them was better than the risk-free investment.

3) The most efficient funds retain high efficiency in all phases of the economic cycle. A significant group of funds performed differently during the different phases of the economic cycle. Most of them performed better during economic growth and generated losses during the period of financial crisis.

4) Evaluation of the efficiency with all eight measures provided similar results for all tested periods. Seven out of eight measures were strongly correlated. The UPR indicator was the only measure whose values, to a lesser extent, coincide with, or was different from, other measure results.

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