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The efficiency of an investing in investment funds in the context of a longevity

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Abstract

Aim/purpose – The aim of this paper is to evaluate the efficiency of an investing in investment funds with different risk levels in times of a future life expectancy increase. For this purpose, it was analysed how future prices of the investment funds' entities behave, depending on the window function and the age of the investors, in particular people of retirement age, for whom an investment income may be a supplementary way of raising additional capital.
Design/methodology/approach – Based on the historical data of the funds chosen from the different risk groups, a simulation of their price behaviour in the window function was carried out covering investor's further life expectancy. Then, based on the result, the distribution of prices was analysed and the efficiency of investing in investment funds according to risk exposure was evaluated.
Findings – According to the conducted analyses, the funds with the lowest efficiency were share funds. The best funds, in terms of efficiency, were bond and money funds.
Research implications/limitations – The study was conducted on a limited number of funds, but this analysis can help take investment decisions.
Originality/value/contribution – In this study, the investment in investment funds is treated as a long-term project which expires after 25-30 years, and therefore it may be problematic to use standard methods of evaluation for the purpose of this paper. As a result, the NPV (Net Present Value) method was applied as a measure of the investment's efficiency. In the literature, this approach to the evaluation of investment funds is unique.

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1. Introduction

Longevity risk is a one of the main risks related to the increasing life expectancy of future pensioners (Trzpiot, 2015a). It indicates that the average value of life expectancy is increasing, which on the one hand, may lead to problems with an insolvency of the pension plans and insurance agencies, whilst on the other, may cause a radical decline in the amount of paid annuities in the future (Trzpiot, 2015b). Hence, it becomes an issue of the quality of life in case of arising limits that are related to the age of people exceeding the life expectancy threshold. Each additional year of life for such a person requires an additional year of monies necessary to sustain it. Therefore, a future pensioner should not wait for their imminent income's decline, but choose an investment strategy that will guarantee the adequate level of the future pension. This kind of rational thinking should be applied long before reaching the upper limit of the productive age, as only in this way may the higher longevity risk be balanced and the financial security be provided (Trzpiot, 2015a).

One of the possible investment methods available on the market are investment funds. It needs to be highlighted that they are perceived as a one of the most secure methods of a raising capital (Jawdosiuk & Rożko, 2010). According to experts, the basic rule of a investing in such funds is that the riskier investing strategy a fund has, the longer the investment holding time should be (Harris, 2014). Hence, as an illustration of share fund brochures, the recommended minimum duration of the investment is in most cases 5 years[3]. By comparison for bond funds, the suggested investment is a period of at least 2 years. Choosing the right fund is not a simple task. Therefore, experts recommend firstly defining how much risk we are willing to take and for how long we are able to wait for the profits (Jajuga, 2009). Namely, those investors who are prepared to risk more in return for the prospects of higher results, should take advantage of the potential of the stock market, whereas individuals who value safety, should probably consider bond or cash fund investments[4]. Searching for new possibilities of plac-

[3] Retrieved December 31, 2018 from https://www.analizy.pl/fundusze/; https://www.gpw.pl/biblioteka-gpw-wiecej?gpwl_id=14&title=Fundusze+inwestycyjne
[4] Retrieved December 31, 2018 from https://www.analizy.pl/fundusze/edukacja/jak-inwestowac/19107/ile-tak-naprawde-mozemy-zarobic-na-funduszach-inwestycyjnych.html

ing additional money means that the investors, i.e. future pensioners, face tough decisions regarding the way of investing, since they alone bear the investment risk, and are fully responsible for any negative effects of their choices. Therefore, it is necessary to conduct an analysis, focusing on the efficiency of the investment funds, which are the basis for choosing a suitable investment strategy. There are multiple analyses of this kind, not only for the Polish investment fund market (e.g. Jurek-Wasilewska, 2014), but also for foreign ones (Grinblatt & Titman, 1989; Kon & Jen, 1979). However, these analyses employed classical and alternative measures of efficiency, based on a standard deviation, a risk premium and an additional rate of return. It should be remembered that this evaluation is of a relative nature; in other words, the rates of return of one fund are compared to the results of other funds. Consequently, the fund with negative, lower than other fund's rates of return may be perceived as the more effective one (Miziołek & Trzebiński, 2017). Additionally, these analyses assumed the time horizon of maximum 10 years (Miziołek, 2000; Stanimir, 2001). There is currently no literature concentrating on the analysis of an investment efficiency in the context of a longevity. The measures commonly reported were usually employed for a short investment period with no reflections of the time value of money. That is why, it is necessary to search for such instruments which could be the basis for the investment evaluation in any window function, including long time horizon.

Therefore, this paper analyses the efficiency of the investments in long-term investment funds on the Polish market, assuming an investor's passive approach, i.e. the investor does not change the fund during the whole period of analysis. The purpose is to evaluate the efficiency of an investing in the investment funds with different risk levels in times of increased life expectancy. It was assumed that the investor is a future pensioner who contributes money to investment fund entities with the aim of long-term investments, and that the 5-year investment will be completed in their lifetime. The results of the investments provided basis for the evaluation of the efficiency of individual's investment funds with regards to their risk exposure and independently of the results of other analysed instruments. As an instrument for the analysis, a widely known measure was employed – namely Net Present Value (NPV). However, it needs to be highlighted that this measure has not been employed before in this type of analysis. In other words, using NPV method bridges the gap, as it is an alternative method to classical measures commonly used and described in the literature (Carhart, 1997; Cogneau & Hubner, 2009; Jensen, 1967). The results enabled the evaluation of individual investment funds, applicable to the Polish market only. Hence, future analyses will need to involve other markets, in order to confirm the hypothesis, according to which funds with high-risk exposure, although recommended by experts as highly effective long-term instruments, are less effective than funds with low-risk exposure.

The literature review covering the analysis of the efficiency of Polish investment funds is presented in this paper. The question of measuring the efficiency, including NPV and the simulating methods, is introduced to the reader. Empirical research forms the basis for drawing conclusions and verifying stated theses.

2. Literature review

Most commonly used methods for evaluating the efficiency of the investment funds are those which employ both the rates of return and the risk involved. The evaluation is based on rankings in which the position represents the value level of applied efficiency measures (Miziołek & Trzebiński, 2017). The top positions indicate outstanding results, whereas the low positions – insignificant ones. However, the main weakness of building and comparing rankings is that the fund efficiency is defined only in correlation to other funds or market portfolios (Miziołek & Trzebiński, 2017). Therefore, it may be concluded that the evaluation of the investment funds' efficiency is limited to defining the type and the level of the risk involved as well as the rate-of-return values and the relation to the market portfolio (Reilly & Brown, 2001). When applying this method, it is worth bearing in mind that the reference point, i.e. a benchmark, may not be represented by the benchmark of the portfolio, but by the 'zero' value. Another possible result is that the fund with the minor loss within the examined group is the best one (Cogneau & Hubner, 2009ab).

In practice, these methods are divided into two groups – traditional and modern ones. The surveys on the efficiency of the Polish investment funds clearly indicate two research streams. The first one employs the Sharpe ratio (Sharpe, 1966), the Treynor ratio (Treynor, 1965), and the Jensen's alpha (Jensen, 1967), as well as their modifications, such as the Sharpe alpha ratio, Information Ratio (IR), and the Modigliani ratio. These methods put emphasis both on the total and the market risk as well as the managers' competence regarding the selection of financial instruments. Characteristic of these methods is the assumption of a neutral approach to the risks.

The three above-mentioned efficiency measures were applied in pioneer analyses regarding the efficiency of the national investment funds, carried out in the works of Miziołek (2000, 2001), in which all the funds between 1997 and 1998, as well as the share funds and the balanced funds of the year 2000 were taken under analysis. What is more, this set of measures became the basis for the works of other authors (e.g. Jamróz, 2013; Jurek-Wasilewska, 2014; Sekuła, 2011; Stanimir, 2001). Other classical measures were applied by Czekaj, Woś & Żarnowski (2001) who, in addition to the Sharpe ratio, the Treynor ratio, and the Jensen's alpha, employed in their studies the Sharpe alpha ratio. However, in the paper of Zatoń (2001), the Modigliani ratio was applied, i.e. the ratio which enables defining the fund's rate of return, based on the total portfolio's market risk.

The second approach to the evaluation of the investment funds' efficiency employs the modern types of measures which do not require an additional assumption regarding the symmetry in the distribution of the rates of return. Here mainly applied are: the Omega ratio (Shadwick & Keating, 2002), the Sortino ratio (Sortino & Price, 1994), or the Carhart four-factor model (Carhart, 1997). These analyses consider the impact of other risk types, such as the size and the value of listed companies, a value exposed to risk, and a negative risk concept. For the Polish fund market analyses, the new efficiency measures, such as tracking error, the generic Sharpe ratio, the Sortino ratio, and the Sharpe–Israelsen ratio, were applied in the papers of Dawidowicz (2007). However, in the paper of Zamojska (2008), the Sortino and Omega ratios were applied as well as the return on VaR and other measures which included the capital loss – the Burke, the Sterling and the Calmar ratios. In 2011, Perez (2011) added additional measures – the Sharp–Omega ratio and the incremental rate of return ratio.

Alternatively, the fund efficiency evaluation may be conducted as well by using methods which consider the abilities of the management. In this case, no investment rankings should be made – the funds are divided into those with positive and negative rates of return. These methods were applied in the research papers of Olbryś (2010), Homa & Mościbrodzka (2016b) and Perez (2012), to name a few, and they employed, e.g. the Jensen's four-factor alpha from the Carhart model and the three-factor alpha from Fama–French model as well as modified market-timing models.

Nevertheless, the presented approaches are not equal. In the first method, the results of managers' decisions are evaluated, whereas in the second one, the abilities of the managers are the key factor for the evaluation. Only a blend of these two approaches provides a complete assessment of the investment fund results (Miziołek & Trzebiński, 2017).

However, it is worth mentioning the attempts of introducing other methods to research as well, such as: the taxonomic (Homa & Mościbrodzka, 2016a), the Bayes' theorem (Sikora, 2010) or the wavelet analysis (Zamojska, 2015).

In this paper, however, the investment in investment funds is treated as a long-term project which expires after 25-30 years, and, therefore, it may be problematic to use standard methods of an evaluation for the purpose of this article. As a result, the NPV method was applied as a measure of the investment's efficiency. This approach to the evaluation of investment fund is unique in the literature.

3. Research methods

3.1. Investment efficiency – Net Present Value

Efficiency should be understood as a result of the actions taken, and in economics, it is defined as the relation between the effects and incurred expenses, thus as the evaluation whether the achieved financial results were, in the investor's opinion, commensurate with the incurred expenses.

As for the investment fund market, it is assumed that a high efficiency fund is the one whose manager accurately forecasts the changes in the market prosperity, skilfully matches the financial instruments with the fund type, and consistently achieves the objectives referring to the risk level and the provisions of the fund's articles (Perez, 2012). The study of the efficiency of the investment portfolios has been a crucial element of research in the financial field for many years. In the literature, there are no clearly outlined instructions that would strictly define which of the efficiency measures should be applied and when.

In the works of Cogneau & Hubner (2009a, 2009b), there are over 100 methods which can be used to measure the efficiency. What is more, many of them have their numerous modifications.

Nevertheless, the majority of these methods measure mainly the results of short-term investments. In the case of long-term investment, the fluctuations of the time value of money should also be considered when analysing the efficiency, and that leads to the conclusion that this type of investment should be treated as a long-term project whose task, in a finite time horizon, is to generate a certain income. Hence, in order to examine the cost-effectiveness of such an investment, other methods should be used which correctly take account of the cash flow throughout the life of the investment. The Net Present Value method is one of these methods and was constructed in accordance with the requirement of the modern financial management. Its asset is that it correctly takes account of the fluctuations of the time value of money and of the cash flows throughout the life of the investment. Net present value is a sum of discounted cash flows generated by the investment, calculated as investment (Jajuga & Słoński, 1997):

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

where
CF_t – cashflows achieved during a period t,
n – the length of investment horizon,
k – a discount rate.

NPV value informs how much the value of invested capital will increase as a result of the completion of the investment. According to the literature (Jakubczyc, 2008):

– if $NPV > 0$, then a project should be conducted (an investment should be started);
– if $NPV = 0$, a project is neutral to the investor;
– if $NPV < 0$, an investment is not profitable.

The discounted rate used in this method may be defined in many ways. In most cases it is described as:

– the rate of return probable to achieve on a market when investing in other projects with a risk level that is similar to the risk level of our investment;
– the cost of capital necessary to provide funds for a project with a given level of risk.

The most frequently chosen discount rate is WACC (Weight Average Cost of Capital), which may be calculated as:

$$WACC = \sum_{i=1}^{n} w_i \cdot k_i$$

where:
w_i – a percentage of a capital from i-source,
k_i – a cost of a capital from i-source in company's capital structure.

In practice, this formula is presented as:

$$WACC = w_d k_d (1 - T) + w_p k_p + w_e k_e$$

where:
w_d– a percentage of the capital of debt,
w_p– a percentage of the capital of preferred shares,
w_e – a percentage of equity,
k_d – a cost of equity capital,
k_p – a cost of preferred capital,
k_e– a cost of company's equity capital,
T – an income tax.

As the investment presented in this paper does not include costs of debt and costs related to the issue of other financial instruments, the rate of income may be defined using the cost of equity capital, which may be estimated using the capital valuation model – CAPM. This model was created by Sharpe (1964), Lintner (1965) and Mossin (1969) and combines the expected return-risk relationship with the risk of the market on which the assets are placed. According to its formula:

$$k_e = k_{RF} + \beta(k_M - k_{RF})$$

where:
k_{RF} – a risk free rate,
k_M – a market portfolio rate of return.

3.2. Simulating method

The Monte Carlo method (MC) was created during the Second World War by John von Neumann and his team. It has been used to model complex processes in such a way that their results may be forecast through the analytical approach. The key role of this method is based on the stochastic choice of variables describing the process. The sampling is carried out according to the distribution of observations that must be known in advance. The accuracy of the result achieved through this method depends on the quantity of repetition and the quality of the Random-Number Generator (Metropolis, 1987). This method involves in particular (Hull, 2011):

– formulating the stochastic models of processes under analysis (real processes),
– modelling variables of known probability distribution,
– solving a statistic problem using the theory of estimation.

This method is simple in theory but very complex in practice. The basis for any consideration is the assumption of a hypothetical model describing the behaviour of rates of return.

Firstly, to carry out the cash flow valuation and define the pay-out – the value of an investment fund portfolio, one must carry out a pricing simulation (with the assumption of the financial market model). Therefore, this research deals with simulating methods and for investment fund pricing employs the Monte Carlo method. In this method, the distribution of the base instrument value at its expiry date was defined by a stochastic process. Knowing this process in advance and applying the Monte Carlo method, through numerous simulations, leads to the result in the distribution of the base instrument final values. In this paper, it is assumed that the investment market is ideal, and the entities of the chosen fund exist, what is described as:

$$dS_t = \mu_S(t)S_t dt + \sigma_S(t)S_t dW_t$$

where:
W_t – the Wiener process (standard Brownian motion process),
S_t – a basic instrument's future price,
S_0– a basic instrument real price,
μ_S – an expected value of process,
σ_S – a process standard deviation.

The only answer to this differential equation is:

$$S_t = S_0 \exp\left(\sigma W_t + \left(\mu - \frac{1}{2}\sigma^2\right) \cdot t\right)$$

This paper uses the simplest pricing model named the standard Brownian motion process, hence the price of the investment fund entity – S_t, is described by it, including an accurate drift ratio which may be defined using the Euler method (Weron & Weron, 2018). Employing this mathematic method, the pricing simulation of investment fund entities in finite number of moments was conducted.

4. Research findings

A survey was conducted on 42 investment fund entities with the longest window function (20 years), quoted in the period of 11.1998-11.2018, including: 11 share investment funds (A), 17 mixed funds (along with 8 stable growth funds (SW), 1 asset allocation fund (MAA), 8 balanced funds (Z), 6 bond funds (including 4 treasury bonds (OS) and 2 universal funds) and 6 investment funds of the money market (PU). The investment fund values were taken from the website stooq.pl.

In this paper, it is assumed that the investor contributes the amount of PLN 100,000 to the chosen investment fund entities, using five types of investment scenarios. Namely: W1 – according to which the investor will contribute the whole sum at the beginning of the research period, W2 – the investor will be regularly investing their capital as annuities every week for 5 years and the capital discounted amount at the beginning is PLN 100,000, W3 – the investor will be regularly investing their capital as annuities every week for 10 years and the capital discounted amount at the beginning is PLN 100,000, W4 – the investor will be regularly investing their capital as annuities every week for 15 years and the capital discounted amount at the beginning is PLN 100,000, W5 – the investor will be regularly investing their capital as annuities every week for 20 years and the capital discounted amount at the beginning is PLN 100,000. At the end of the investment period (after 20 years) the number of entities purchased by the investor within the whole research period was defined (Table 1).

Table 1. The number of entities purchased by the investor in using five types of investment scenarios

Scenario	**PU41**	**PU36**	**PU34**	**PU20**	**PU14**	**PU10**	**MAA6**	**OU25**	**OU26**	**OS21**
W1	1334	7968	6716	943	984	908	894	978	93	987
W2	1093	6681	5616	755	793	734	813	804	73	778
W3	1015	6310	5288	707	746	691	697	751	68	705
W4	960	6087	5086	682	729	670	672	702	62	650
W5	936	6031	5046	676	725	664	687	684	60	626
Scenario	**Z3**	**SW28**	**SW26**	**SW24**	**SW22**	**SW21**	**SW20**	**SW17**	**SW12**	**A52**
W1	616	1990	10000	10173	1956	1565	741	975	9921	2325
W2	520	1569	8238	11088	1565	1312	688	825	8099	1672
W3	471	1352	7061	10612	1390	1188	652	752	7272	1303
W4	463	1278	6563	10204	1337	1169	679	740	7013	1162
W5	445	1241	6384	10167	1331	1158	712	760	6766	1105
Scenario	**OS15**	**OS13**	**OS5**	**Z13**	**Z12**	**Z10**	**Z7**	**Z6**	**Z5**	**Z4**
W1	1981	4769	932	1137	928	9452	1541	1088	912	892
W2	1580	4031	754	874	753	8399	1383	996	823	756
W3	1452	3735	705	734	641	6902	1227	908	716	656
W4	1366	3516	677	676	614	6469	1236	973	722	629
W5	1316	3430	665	654	607	6341	1242	1052	764	616
Scenario	**A47**	**A44**	**A42**	**A38**	**A35**	**A32**	**A30**	**A24**	**A23**	**A19**
W1	1173	10091	988	1896	5008	883	1039	563	1251	881
W2	985	8397	789	1824	5045	902	846	501	1151	882
W3	763	6331	634	1527	4319	751	687	433	935	694
W4	697	5762	600	1489	4714	730	653	425	915	618
W5	678	5645	597	1530	5235	763	639	427	876	593

In the next step of every scenario, based on historical values of the analysed investment fund entities, a simulation of the portfolio values (100,000 implementations) was made, in two window functions, depending on the duration of life (T1-5 and T2-10 years – resulting from the adjustment of the anticipated life expectancy).

Based on the results, for every generated portfolio value, the NPV was calculated. To calculate the discounted value of cash flows, the discount rate was determined, using the beta of investment and market interest rates (benchmarks) characteristic for the stock, mixed, bond and cash markets.

Table 2. Basic distribution parameters for investment funds – T1

T1	mean	median	min	max	standard deviation	variability	asymmetry	kurtosis
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
PU41	67264	49138	−48838	334960	80709	1.1999	0.9538	0.4467
PU36	37028	27306	−46955	204030	53486	1.4445	0.7802	0.1091
PU34	27462	18221	−50157	183100	49641	1.8076	0.7897	0.1109
PU20	41209	31396	−45031	211720	54632	1.3258	0.7763	0.1070
PU14	43865	34582	−40168	203050	52389	1.1943	0.7300	−0.0124
PU10	42290	32751	−43257	208600	53926	1.2751	0.7462	0.0190
OU25	60788	43623	−51606	324320	78363	1.2891	0.9729	0.5200
OU26	82385	58499	−52045	424620	98694	1.1980	1.0726	0.7566
OS21	100680	71747	−50973	505770	114320	1.1355	1.1348	0.9260
OS15	96800	69906	−49756	475370	108140	1.1171	1.0927	0.8060
OS13	78607	59692	−45026	368050	86465	1.1000	0.9696	0.5153
OS5	81096	60318	−46600	387420	90543	1.1165	0.9951	0.5563
MAA6	−62335	−65147	−85682	−14883	15064	0.2417	0.8084	0.1574
Z13	−18567	−30331	−80502	147460	46581	2.5088	1.1374	0.9517
Z12	−41822	−47466	−81043	45895	26702	0.6385	0.9258	0.4015
Z10	−35221	−43783	−83314	87977	35398	1.0050	1.0750	0.7640
Z7	−47560	−51057	−78595	11719	19504	0.4101	0.7411	0.0057
Z6	−72372	−74164	−88695	−41094	10164	0.1404	0.7428	0.0382
Z5	−68393	−70669	−87777	−29525	12427	0.1817	0.7968	0.1431
Z4	−36488	−43241	−80520	65696	30784	0.8437	0.9664	0.4843
Z3	−7143	−21610	−79095	193470	55342	7.7473	1.1721	1.0341
SW28	−18538	−28340	−76985	124960	41869	2.2586	1.0259	0.6438
SW26	−19316	−29517	−78009	127630	42646	2.2078	1.0489	0.6918
SW24	−64185	−66614	−85725	−22325	13598	0.2119	0.7532	0.0459
SW22	−38018	−42877	−76875	42150	25311	0.6658	0.8193	0.1778
SW21	−28269	−33479	−72320	60385	28332	1.0022	0.7950	0.1195
SW20	−63427	−64342	−78358	−41045	8168	0.1288	0.4602	−0.3910
SW17	−52158	−54619	−77565	−7262	15219	0.2918	0.6436	−0.1500
SW12	2012	−10981	−72678	193310	54615	27.1390	1.0859	0.8309

Table 2 cont.

1	2	3	4	5	6	7	8	9
A52	−31276	−45419	−88398	154560	8814	1.5346	1.3732	1.6684
A47	−53462	−61467	−90493	55657	29493	0.5517	1.2449	1.2561
A44	−47986	−58299	−90835	90205	35733	0.7447	1.3516	1.5975
A42	−61747	−67307	−90791	16466	22001	0.3563	1.1320	0.9119
A38	−80733	−83091	−94715	−46351	10077	0.1248	1.0262	0.6325
A35	−84353	−87321	−97095	−44908	10464	0.1241	1.3111	1.4553
A32	−75885	−79066	−93687	−30294	13052	0.1720	1.0734	0.7670
A30	−50559	−58198	−88728	55865	29415	0.5818	1.1747	1.0392
A24	−49121	−54365	−84298	31032	24278	0.4943	0.9431	0.4368
A23	−54356	−63540	−92182	69507	31882	0.5865	1.3796	1.7079
A19	−51935	−61511	−91632	75345	33238	0.6400	1.3461	1.5553

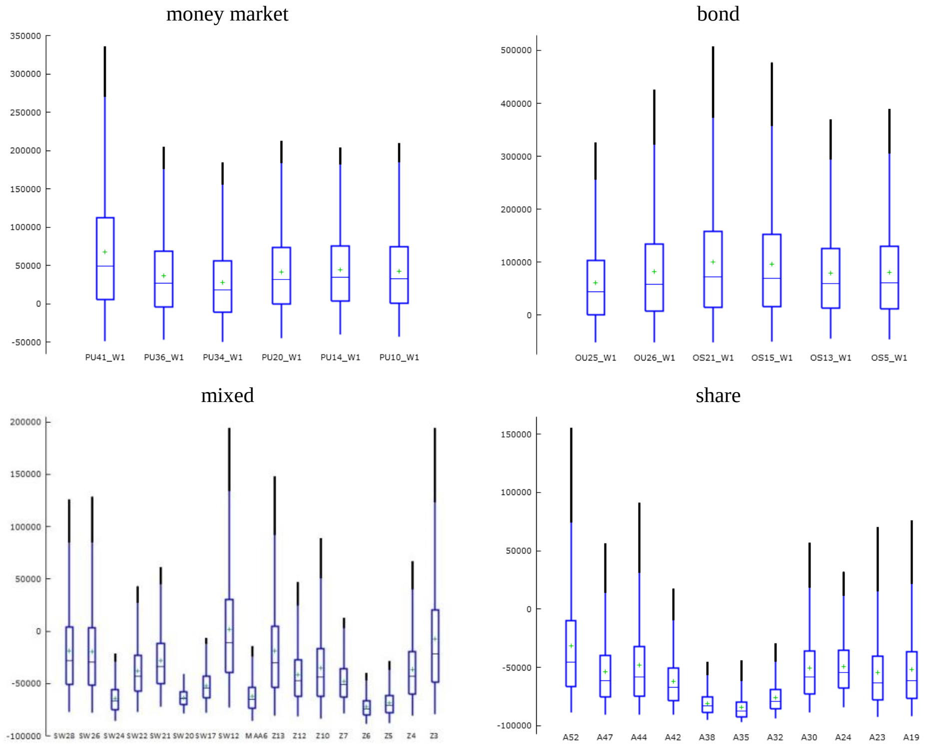
In the next step, the distribution of the results was analysed by the group of a fund and investment scenarios. Since the quantity of bought entities was the biggest in W1, the results of the simulation will be represented for this particular scenario (Table 2). The results of simulations in other scenarios were similar in terms of received correlations[5].

Figure 1 presents the behaviour of the distribution of the NPV in several investment fund groups. It may be observed that the bond fund and money market fund groups were the most homogeneous in terms of risk and efficiency, as the values of NPV and standard deviations were similar. The share fund investments were the second group in terms of NPV homogeneity, but the effectiveness of these investments was the lowest and always negative with the volatility not exceeding 150%.

The mixed investment funds turned out to be the least homogeneous portfolio group in terms of efficiency, as the average NPV had the biggest volatility in their case. However, in terms of risk, it may be observed that this group has the biggest risk exposure. Nevertheless, the average efficiency measured by the average NPV was higher than in the case of share investment funds.

[5] Due to limitations, full results can be made available on request.

Figure 1. Box plots of NPV values in individual groups of investment funds – T1

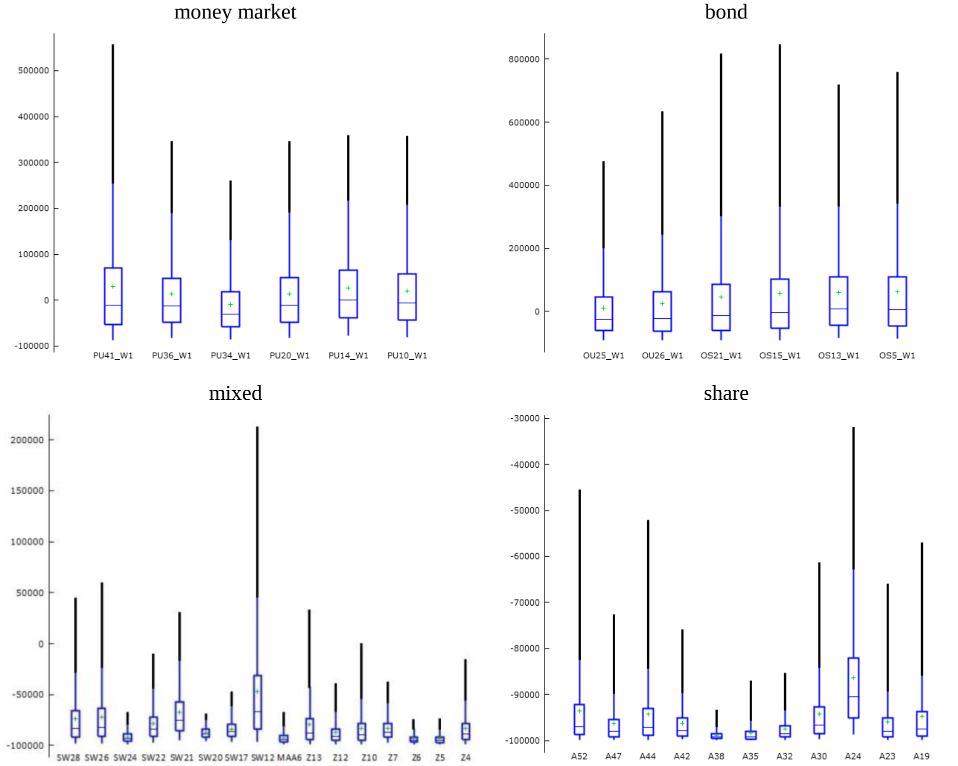


When the investment period extended over 10 years, there were no changes in trends of the results achieved. Namely, the most efficient funds, in terms of average NPV, were those with the lowest risk exposure. Even though their average efficiency declined (Table 3), it was still in plus, contrarily to the results of share funds for which the NPV did not exceed the point of PLN −80 000. However, the investment volatility increased in each case. The biggest fluctuation of these results may be observed among the bond and money market investment funds. These changes can be seen in Figure 2, in which the behaviour of the NPV for each and every representative of individual fund subgroup is presented.

Table 3. Basic distribution parameters for investment funds – T2

T2	mean	median	min	max	standard deviation	variability	asymmetry	kurtosis
PU41	30152	11114	−87878	555350	119790	3.9727	1.7700	3.1615
PU36	12438	12759	−83040	344650	83585	6.7200	1.4626	1.9885
PU34	9585	30031	−86095	258440	67161	7.0068	1.4625	1.9553
PU20	13107	10814	−82727	343920	83360	6.3599	1.4552	1.9640
PU14	25521	67	−78039	356900	86890	3.4046	1.3542	1.5664
PU10	19662	5837	−80800	356310	86137	4.3809	1.3968	1.7295
OU25	11180	−24424	−90125	473530	103960	9.2982	1.8140	3.3794
OU26	24980	−22165	−91685	630580	130100	5.2081	1.9897	4.1477
OS21	45693	−13575	−91720	813630	160160	3.5052	2.0973	4.6738
OS15	57425	−3716	−90145	843200	166600	2.9012	2.0207	4.2951
OS13	59889	9113	−85160	715760	148550	2.4804	1.8074	3.3525
OS5	61140	6828	−86339	755360	154610	2.5288	1.8474	3.5147
MAA6	−92242	−94057	−98875	−68418	5921	0.0642	1.5037	2.1204
Z13	−79157	−87665	−98861	32120	23009	0.2907	2.1169	4.8144
Z12	−87357	−91069	−98673	−39632	11125	0.1274	1.7145	2.9205
Z10	−83233	−89623	−98931	−732	17605	0.2115	2.0019	4.2265
Z7	−83319	−86814	−97193	−38243	11793	0.1415	1.3779	1.6496
Z6	−93415	−94765	−98885	−75532	4611	0.0494	1.3865	1.7145
Z5	−93617	−95066	−99041	−74564	4788	0.0511	1.4840	2.0463
Z4	−83487	−88745	−98478	−16480	15346	0.1838	1.7897	3.2226
Z3	−63212	−79130	−98240	146640	42273	0.6688	2.1788	5.1302
SW28	−73948	−83091	−97980	43743	25741	0.3481	1.9073	3.7975
SW26	−72073	−82285	−97995	58808	28373	0.3937	1.9450	3.9413
SW24	−91577	−93385	−98650	−67891	6080	0.0664	1.4108	1.7821
SW22	−78560	−83780	−97012	−10714	16704	0.2126	1.5281	2.2154
SW21	−67502	−74935	−95140	30049	24471	0.3625	1.4763	2.0074
SW20	−87299	−88358	−95426	−70179	5348	0.0613	0.8518	0.2406
SW17	−83765	−86406	−96361	−48239	9792	0.1169	1.1954	1.0984
SW12	−46824	−66491	−96323	211860	55016	1.1749	2.0199	4.3408
A52	−93499	−96956	−99832	−45722	8814	0.0943	2.5385	7.1550
A47	−96256	−98008	−99855	−72859	4586	0.0476	2.3118	5.8352
A44	−94201	−97212	−99836	−52315	7729	0.0820	2.5025	6.9561
A42	−96227	−97777	−99792	−76055	4178	0.0434	2.0998	4.7021
A38	−98839	−99254	−99915	−93534	1164	0.0118	1.9119	3.7907
A35	−98365	−99187	−99948	−87296	2117	0.0215	2.4247	6.4591
A32	−97558	−98482	−99839	−85592	2543	0.0261	1.9977	4.2226
A30	−94234	−96717	−99717	−61495	6619	0.0702	2.1782	5.1175
A24	−86311	−90561	−98717	−32091	12501	0.1448	1.7580	3.1030
A23	−95964	−98089	−99893	−66139	5482	0.0571	2.5583	7.2995
A19	−94749	−97490	−99855	−57166	7023	0.0741	2.4810	6.7604

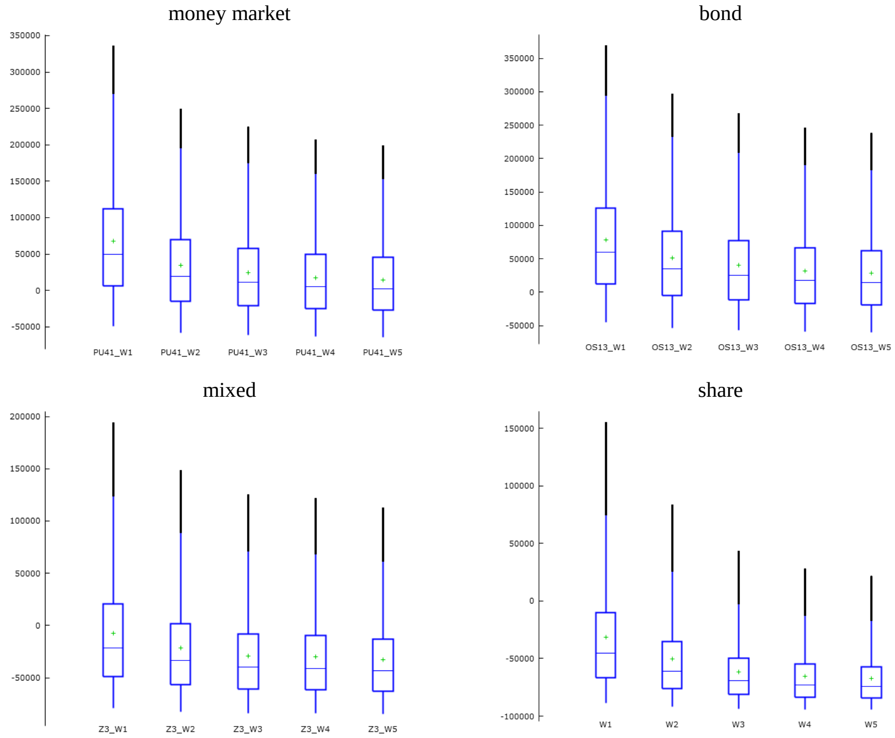
Figure 2. Box plots of NPV values in individual groups of investment funds – T2



Subsequently, from every investment fund group, the funds with the highest efficiency were chosen. The distribution of their NPV with the box plots are illustrated in Figure 3. It may be observed that, in terms of the NPV achieved, the leaders were the funds which on the investment fund market are perceived as those with minimum risk, namely the money market and bond funds. For those funds, the average NPV reached from PLN 61,000 in W1 to PLN 14,000 in W5 and from PLN 79,000 in W1 to PLN 28,400 in W5 (and was always positive), with the variability from 120% (in W1) to 375% (in W5) for money market IF and from 110% (in W1) to 220% (in W5).

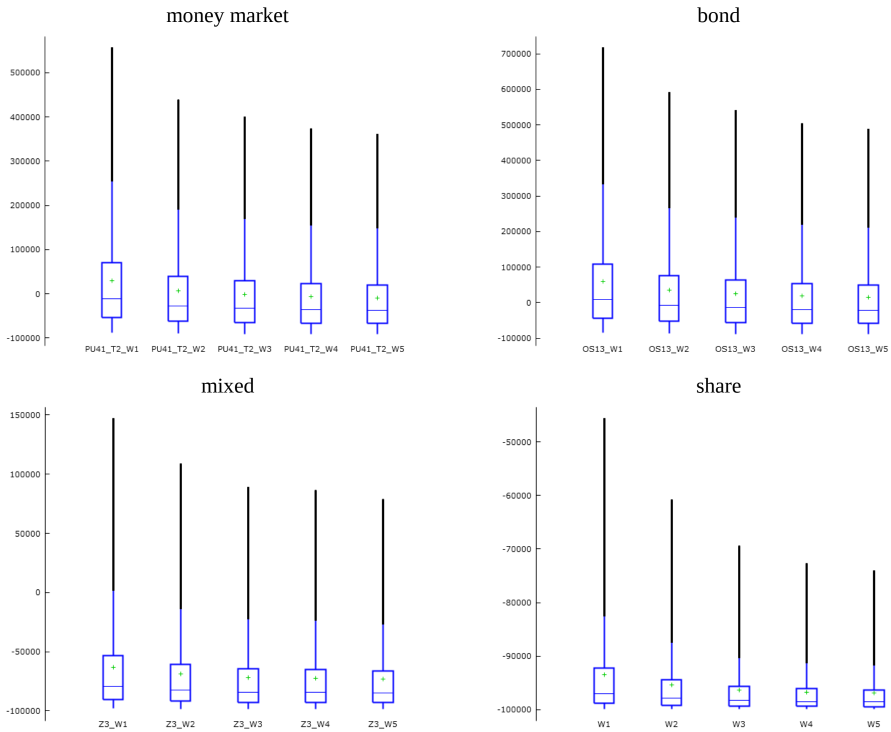
What is more, it may be observed that in these scenarios which prolong payments, the efficiency of all the investment fund groups declined, both in the case of funds with the highest and the lowest efficiency. This means for the investor that contributing their money at the very beginning would be a better solution with more effective results.

Figure 3. Box plots of NPV values in scenario W1-W5 for funds with the highest efficiency in the group (T1)



When the investment period extended over 10 years, there were no changes in trends of the results achieved (Figure 4). Only the variability of NPV increased.

Figure 4. Box plots of NPV values in scenario W1-W5 for funds with the highest efficiency in the group (T2)



5. Conclusions

The results of the analysis are the extension of the existing research on the use of NPV in an investment evaluation from the investor's point of view. Thereby, these results indicate the best and the worst investment methods:

1) The funds with the lowest efficiency are share funds. Their average efficiency in the group in the shortest investment period was at PLN –58,310, with the risk measured by the standard deviation of PLN 22,500. While the investment period was exceeding, the efficiency of these types of instruments was declining (up to PLN –95,100), and the risk was decreasing up to PLN 5,700.
2) The best funds, in terms of efficiency, were the bond and money funds, for which the average efficiency in the group in the shortest investment period exceeded PLN 83,300 and PLN 43,100, respectively, with the risk measured by the standard deviation at PLN 96,000 and PLN 57,000.

As a result, it may be stated that the efficiency of investment funds on the Polish market has declined along with the investment period increase, but the average NPV was still positive. Hence, the research shows that along with the investment period increase, the funds with high-risk exposure may not serve their function of capital multiplication and, what is more, their efficiency in long window function declines. This may suggest that in the case of 'passive' investments investors should opt for investments with lower risk as they may guarantee higher income over a long-time horizon. Hence, the results of this analysis do not confirm the experts' opinion, according to which the riskier an investment fund strategy is, the longer the time horizon should be.

The results of such an analysis would serve as a recommendation for practitioners, e.g. fund managers or individual investors, for whom this will be a simple criterion for making decisions according to a chosen investment strategy over a long-time horizon, which is not shown by the classic measures of investment effectiveness.

It needs to be highlighted that the results of this analysis only refer to the Polish investment fund market, and that undoubtedly leads to limits in drawing conclusions. As a result, the question arises if this feature characterises only the individual Polish market or may be typical of other investment fund markets. The crucial aspect is that in order to verify hypothesis which would include foreign markets it is necessary to extend the research, as there are no studies that present similar approach. Hence, future analysis will be focused on verifying hypotheses referring to individual European markets at various stages of development.

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