

# Similarity of Open-Ended Mutual Funds During a Pandemic. Research for Equity and Bond Funds



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**Abstract** Studies of investment funds in rate of return and risk are often insufficient. Similarity analysis is able to broaden this assessment by linking these variables together. This allows the investor to make an appropriate choice of funds by either minimising risk or selecting a single fund with a different investment policy. The aim of this research is to analyse the similarity of investment funds in terms of their performance and risk taken in two periods: the period of great uncertainty caused by the existence of a pandemic and the period immediately preceding it. The performance of funds in adjacent positions in the ranking turned out to be similar to each other. In the case of determining fund similarity, greater variation in performance appeared during the pandemic period, as indicated by more clusters and greater distances between bonds in the second period for equity funds. For bond funds in the pandemic period, slightly larger distances between bonds in period two are evident with a similar number of clusters. There are also more 1-element clusters in period two.

**Keywords** Open-ended mutual funds · Risk · Pandemic · Similarity · Ward's method

## 1 Introduction

Investment funds have been providing investors with the opportunity to invest their financial surpluses for nearly thirty years. Due to the emergence of new types of funds investing in very different assets, this is an increasingly popular form of investment. The share of household savings in investment funds in Poland accounts for around 8% of total household savings.

It is not easy for an investor to decide which form of investment and which asset to choose. An informed choice should be profit-oriented, but taking into account acceptable risks. In a period of crisis, such as the pandemic caused by the SARS

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Cov-2 virus, investor decision-making is even more difficult. The uncertainty that exists during this period is reflected in the greater volatility of asset prices and eventually entire markets (Wang et al. 2021). Many investors shift their surpluses into less risky assets. Those with a higher risk appetite in turn undertake to invest in assets that stand to gain in a pandemic.

In the case of investment funds, a search is also being made for funds or types of funds that would generate a higher return on investment than others. Various fund characteristics are therefore being studied and their impact on performance. One characteristic is the size of the fund. It often influences the performance of a fund (Liang 1999; Holmes and Faff 2007). But depending on the other attributes affecting the fund or the investment policy pursued, these funds can be more or less similar to each other in terms of performance and risk from that investment. And this, even within a given group, could make it possible to identify both funds from the same clusters and individual clusters in which funds may generate higher results than others.

The aim of the research is to analyse the similarity of investment funds in terms of the results and risk taken in two periods: the period of great uncertainty caused by the existence of the pandemic and the period immediately preceding it. This will allow the identification of better-performing funds as well as the observation of fund similarity in the period of the pandemic.

The paper is organised as follows. Section 2 reviews the literature. Section 3 describes the methods used in the paper. Sections 4 and 5 deal with the description of the results. The paper ends with conclusions in Sect. 6.

## 2 Literature Review

The study of fund performance is the subject of analysis in many markets. Most work focuses on the US market, mainly because it is a developed market. In the case of the European market, mainly single countries or groups of countries are studied in order to compare the results. Studies for groups of countries have been done by Otten and Bams (2002), Božović (2021), Graham et al. (2020), among others. The research of Otten and Bams (2002) focuses on the markets of France, Germany, Italy, the Netherlands and the United Kingdom. These countries' markets cover over 66% of all investment funds in Europe. For four of the five countries, the funds outperformed the market portfolio. In contrast, the US-based European funds studied were unable to outperform from a passive strategy (Božović 2021). Poor performance is also characteristic of long-only European funds (Graham et al. 2020).

Single country studies have been conducted by Leite and Cortez (2009), Babalos et al. (2012), Ferreira et al. (2013), Białkowski and Otten (2011), Vidal-García (2013), among others. Leite and Cortez (2009) studied the Portuguese investment fund market. They confirmed the inability of mutual fund managers to receive better results than from the market. Babalos et al. (2012) indicated only a small percentage of funds being efficient. Different results were obtained by Białkowski and Otten

(2011) for the Polish market. Studying stock, mixed and bond funds from the period 2000–2008, they pointed to the advantage of domestic funds and stability of results up to 1 year. The stability of results was also confirmed by Vidal-García (2013) for six European fund markets.

Studies conducted for mutual funds indicate that in most cases, funds are not able to generate better performance than the market. Some studies also show that funds that are actively managed in most cases also generate lower returns than the market portfolio (Berk and van Binsbergen 2015). The opposite results are very rare (Kosowski et al. 2006). Even those funds that generate the best results do not provide a guarantee of the stability of their performance (Mateus et al. 2019).

The impact of fund size on fund performance has been widely studied in the literature. Initially, there was a belief that smaller funds were able to outperform larger ones due to their liquidity (Grinblatt and Titman 1989; Prather et al. 2004; Ammann and Moerth 2005). Subsequent studies of many markets have often given contradictory results, e.g. Liang's (1999) study. He indicated that as fund size increases, performance also increases. Research on various markets has also not given a clear answer as to the existence of a relationship between size and performance. Some indicated the presence of correlation (Holmes and Faff 2007) and others to the absence of them (Ferreira et al. 2013; Gregoriou and Rouah 2002).

Fund similarity testing is an issue that is rarely used in the literature. Among other things, clustering methods are recommended for new funds that cannot be evaluated in terms of performance based on historical data (Sakakibara et al. 2015).

The clustering methods used are usually based on risk or return (Pattarin et al. 2004; Lytkin et al. 2008). It also happens that more variables are selected to determine clusters (Acharya and Sidana 2007). Due to the small number of studies and the use of the k-means method for determining the clusters, there is a need to analyse the funds in terms of their similarity and compare the results obtained using Ward's method in the period of the pandemic and just before it.

### 3 Research Methodology

The study covers the period March 2019–February 2021 and has been divided into two sub-periods: 1 March 2019–28 February 2020, 2 March 2020–28 February 2021. Due to the fact that March 2020 was taken as the start of the pandemic period and the study ends in February 2021, period I was selected to have a similar length. Hence, March 2019 was considered as the start date of the study.

The research concerns two types of open-ended investment funds—equity funds and bond funds. Deliberately, we focused on such types of funds in which the risk level is the highest and the lowest. Due to the occurrence of the effect of new funds on the Polish market, the funds which existed at least 1 year before were admitted to the research. Thus, using the purposive selection method, 50 stock funds investing on the Polish market and 17 funds investing mainly in Treasury bonds were selected.

Due to the fact that, in case of Polish market, there is a proven influence of fund size on its results (Żebrowska-Suchodolska 2021), funds were divided into four groups. In each period, this division was made separately. The net asset size quartile determines here the point of division.

Fund characteristics such as ordinary rate of return and risk are the basis for further research. The simple rate of return reflects the profit (or loss) made by the investor:

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

where  $p_t$ ,  $p_{t-1}$  are the value of fund units.

Risk, on the other hand, is understood as deviation from the average. It can be considered as both a neutral and a negative concept. In the former concept, it is all deviations from the average, both above and below the average. Representative of this concept is for example the standard deviation described by the formula:

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

where  $\bar{r}$  is average rate of return.

The negative concept refers to a negative deviation from the mean. Therefore, it is perceived by the investor as a loss that can be achieved from the investment undertaken. Such a measure in the negative concept is, among others, the semi-standard deviation. It is represented by the formula:

$$\sigma^- = \sqrt{\frac{1}{N-1} \sum_{t=1}^N ((r_t - r_{min})^-)^2} \quad (3)$$

where  $((r_t - r_{min})^-)$  is the negative deviation of the rates of return from the break-even point  $r_{min}$ . The study assumes  $r_{min} = 0$ .

The rate of return and standard deviation and semi-standard deviation provide the basis for an initial assessment of performance and risk from this investment. A one-factor ANOVA was used to examine the differences between the average returns of the different groups (Aczel 2005). However, given that fund performance within a group can be very similar to each other and a given fund may differ from the fund preceding it in the ranking at some decimal point, it is worth enriching the evaluation of funds with a similarity analysis. This gives a broader picture of how a fund is rated against other funds. Methods of cluster analysis are helpful here, among which the hierarchical Ward's method was chosen (Ward 1963; Walesiak 1994). It allows objects grouping into homogeneous clusters characterised by the minimum variance (Walesiak and Dudek 2009). The method of implementation in Ward's method is to start with a one-element cluster treated as a separate object. Then a two-element cluster is created, and so on. The distance of an object from a cluster is determined

by minimising the sum of squares of deviations inside the clusters. The calculations last until all objects are gathered into one cluster. The distance in Ward's method is understood as the Euclidean distance (Walesiak and Gatnar 2012). Calculations were made on the basis of Statistica.

The application of the steps described will contribute to the confirmation of the following theses:

- H1: the performance of funds in adjacent positions in the ranking is similar to each other.
- H2: before the pandemic, there is a greater similarity between equity funds than during the pandemic period.
- H3: the similarity between bond funds is close in both periods.

## 4 Characteristics of the Selected Funds

The initial stage of research is to assess the funds in groups, determined by their size. It is understood here as the value of their net assets, i.e. the value of a fund's assets after deducting its liabilities. The net asset values for both equity and bond funds in both periods are given in Table 1.

In equity, funds open in the first period were placed over 783 million PLN in total in all groups, whereas in the second period nearly 716 million. Thus, we observe a decline in assets in the second period by 8.6% compared to the first period.

In the case of bond funds, the volume of funds invested in the first period amounts to PLN 2.77 billion, and in the second period—PLN 3.07 billion. These values exceeded by more than three times the assets of equity funds in the first period and more than four times in the second period. In the second period, there is also a visible increase in the assets of bond funds compared to the first period by almost 20%. Thus, one can see a shift of funds from more risky investments to less risky ones. These are bond funds in this case.

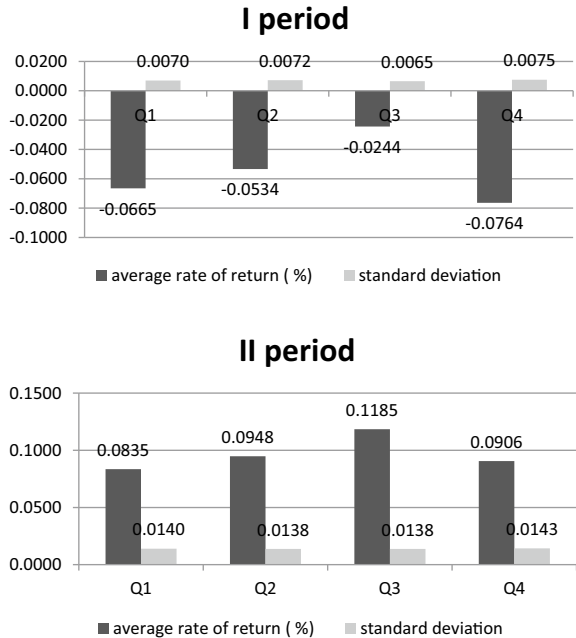
The average values of return rates, standard deviation and semi-standard deviation were determined for the funds from each group and period. Beforehand, however, missing data were filled in the downloaded series of values of participation units. Blank values that were missing on a given day were replaced by values from the

**Table 1** Net asset value of equity and bond funds in the periods under review

Group	Equity funds		Bond funds	
	I	II	I	II
Q1	32,521,349.52	27,301,566.81	37,222,304.45	40,969,269.68
Q2	78,038,250.03	67,059,374.55	134,520,662.80	201,127,989.55
Q3	143,932,569.87	148,044,061.56	531,241,785.66	526,126,082.99
Q4	528,523,893.55	473,521,086.56	1,862,352,575.74	2,298,439,566.13

Source Own study

**Fig. 1** Return and standard deviation of equity funds in both periods



previous day. Figures 1 and 2 show the results of average rates of return and standard deviation for both equity and bond funds in both periods.

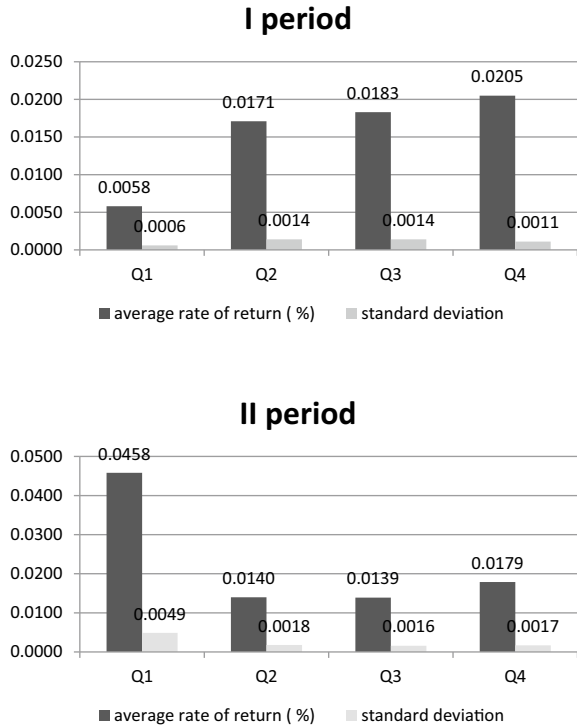
In period 1, all equity fund groups have negative average returns. The average return performance in period 1 is a reflection of the market declines that occurred in the run-up to the pandemic period. The reaction of the equity fund market therefore started earlier, and funds started to recover after March 2020. In period II, after the strong reaction to the pandemic, the average performance of returns is positive. It can also be noted that the best performance was achieved by group three. Admittedly, in period on its performance is comparable to the other groups, but with lower risk. In period two, however, group three clearly benefited from economies of scale, which allowed it to achieve better results.

The results of average rates of return and standard deviation for bond funds are presented in Fig. 2.

In the case of bond funds, returns in period one are between 0.01 and 0.02%. In period 2, there is a decrease to 0.01 in two groups, while the results for group four remain unchanged. The decrease in performance is related to the reduction in bond interest rates that took place in April 2020. Only group one saw an increase to 0.05 in the second period, also with an increase in risk. There were therefore other assets in the funds' portfolio that contributed to this increase. In period 1, however, these influenced the decline in performance. The stable performance of group four is due to the economies of scale of the largest group (fourth).

Taking into account the risk, its values are similar both in individual groups and in both sub-periods. Average values of standard deviation for equity funds range

**Fig. 2** Return and standard deviation of bond funds in both periods



from 0.0065 to 0.0075 in the first period, and from 0.0138 to 0.0143 in the second period, with values in the second period being slightly higher, probably due to greater uncertainty related to the situation in the pandemic period. The values of the semi-standard deviation are lower due to the very definition of this measure, which only includes negative deviations from the mean. However, its close values to the standard deviation indicate that there are more negative than positive deviations from the mean. Values of standard deviation are also not  $\sqrt{2}$  times higher than semi-standard deviation, which indicates occurrence of outliers in the studied series.

The average standard deviation values for bond funds range from 0.0006 to 0.0014 in period one and from 0.0014 to 0.0034 in period two. The semi-standard deviation values here are lower than the standard deviation values. In the case of bond funds, the values of the standard deviation are almost  $\sqrt{2}$  times larger than the semi-standard deviation, especially in period one. In period 2, this property is already less noticeable.

In the case of financial time series, the occurrence of outliers is a frequent situation, because they are characterised by the occurrence of fat tails, and this in turn means that the probability of outliers is higher than in a normal distribution. This situation occurs in a period of relative stability, and all the more so in a pandemic period, when there is much greater uncertainty and with it much greater volatility.

## 5 Evaluation of Fund Performance and Similarity

The next stage of the research is to create a ranking of the funds for each group in each period separately. The results for the equity funds from the first period are shown in Table 2. The funds have been numbered sequentially without being named. This is because the paper aims to examine similarity within fund groups rather than focusing on specific funds.

**Table 2** Performance of equity funds in the first period

Fund	Ranking position	Average rate of return (%)		Ranking position	Average rate of return (%)
Group Q1			Group Q3		
F8	1	-0.0138	F29	1	0.029910
F6	2	-0.0308	F33	2	0.015019
F10	3	-0.0475	F31	3	-0.00210
F13	4	-0.0523	F32	4	-0.01288
F2	5	-0.0577	F26	5	-0.01717
F11	6	-0.0644	F36	6	-0.03668
F9	7	-0.0676	F37	7	-0.03789
F1	8	-0.0694	F35	8	-0.03909
F5	9	-0.0725	F28	9	-0.03914
F4	10	-0.0789	F27	10	-0.03958
F12	11	-0.0849	F34	11	-0.04204
F7	12	-0.1002	F30	12	-0.07064
F3	13	-0.1249	Group Q4		
Group Q2			F40	1	-0.03969
F22	1	-0.0044	F46	2	-0.05481
F24	2	-0.0150	F48	3	-0.05772
F25	3	-0.0187	F41	4	-0.05890
F15	4	-0.0217	F50	5	-0.06764
F14	5	-0.0255	F38	6	-0.07353
F17	6	-0.0297	F43	7	-0.07648
F19	7	-0.0630	F42	8	-0.08242
F21	8	-0.0634	F44	9	-0.08863
F16	9	-0.0647	F49	10	-0.08995
F20	10	-0.0756	F47	11	-0.09565
F23	11	-0.0905	F45	12	-0.09990
F18	12	-0.1689	F39	13	-0.10761

Source Own study



Average rates of return of individual equity funds in group 1 of the first period confirm the average results for the funds obtained within the entire group. Group 3 in period 1 obtained the highest average results, followed by group 2, 1 and finally 4. The largest divergence of results took place in group 2, followed by groups 1,3 and 4. The results of many funds located in adjacent positions in the ranking were very similar to each other. Therefore, it is rather worth talking about better and worse funds within a given group. In the case of bond funds in the first period, the groups themselves recorded similar results. This also translates into a similar range of obtained results, and within the group—even similar results of the best and the worst funds.

In the second period, equity funds with diversified results recorded a very similar range of results, with the values of rates of return in groups 3 and 4 being higher. For bond funds, the smallest performance spread was in group 4 and the largest in group 1.

The division of funds into individual groups and the rankings created on the basis of rates of return can be the subject of both in-group and intergroup research. In order to check whether differences in rates of return between groups are statistically significant, one-way ANOVA was used. In the case of equity funds, significant differences between groups occurred in subperiod I. In period II, average values between groups did not differ. Fund managers, often pursuing different investment policies in the first period, may have tried to apply a more cautious approach in the second period, which made the results of the funds more similar to each other. For bond funds in both the first and second periods, the differences in average returns between groups were not statistically significant. This is perhaps due to investing in similar assets.

A ranking based on returns is not a complete picture. Funds with similar rankings may differ in terms of risk because of, for example, different managers' investment policies, even within the same fund type. Therefore, looking at funds together in terms of their performance as well as their risk may help the investor in deciding which fund to choose.

The next step was therefore to examine the similarity of funds in both periods in terms of their performance and risk. Therefore, the similarity in individual groups for stock and bond funds in both periods was examined. Separately, similarity was also determined taking into account standard deviation and semi-standard deviation. The cut-off was determined as the largest increment of edges between created clusters on the agglomeration chart. The number of clusters created in this way is presented in Table 3.

For equity funds, an increased number of clusters is observed during the pandemic period. So despite outperformance, funds have been characterised by greater diversification. This may be due to the fact that when the market is more stable, funds often limit themselves to just following the market. Here, however, when the situation becomes very uncertain, they try to cope with it by applying their own investment policy.

Bond funds have behaved very differently. Here, the pandemic did not significantly affect the different number of clusters. However, the clusters did not include the same funds, which means that bond funds were also trying to adapt to the new situation.

**Table 3** Number of clusters obtained from Ward's method

Period	Equity funds	Q1	Q2	Q3	Q4
I	Standard deviation	3	3	3	4
	Semi-standard deviation	3	4	4	4
II	Standard deviation	5	4	4	7
	Semi-standard deviation	4	4	4	5
	Bond funds				
I	Standard deviation	2	2	2	2
	Semi-standard deviation	2	2	2	2
II	Standard deviation	3	2	2	2
	Semi-standard deviation	3	2	2	2

Source Own study based on statistica

The occurrence of outliers in the data results in a larger number of clusters, but most of all single-element clusters. This is the case with equity funds in group 4 in both periods when taking into account the risk as a standard deviation and semi-standard deviation. Single-element clusters also appear in group 2 when understanding risk as standard deviation and semi-standard deviation.

Single-element clusters also appear in the case of bond funds, but here, because of the small number of funds in the group and the small dispersion of results, each result that differs at least a little from the other results will generate a single cluster. These do not have to be outliers, because in the case of bond funds these occur sporadically, as indicated by the relationship between standard deviation and semi-standard deviation.

On the basis of the obtained dendrograms, the presentation of which was omitted due to the limitation of the paper, it is difficult to draw unambiguous conclusions regarding differences in bond distances in both study periods. The bond distances here change both depending on the group, the study period, but also on the risk measure that is taken into account.

The results obtained, therefore, indicate their instability. Funds in the same cluster in period one are often in different clusters in period 2, even when they are in the same group in terms of net asset value. It is also worth noting that funds in given clusters do not coincide with the ranking positions created. Considering return and risk separately will therefore not produce similar funds (Terraza and Toque 2021).

## 6 Conclusions

The results obtained in the research confirm the hypotheses put forward in the paper. In the case of equity funds, the best results were achieved by the third group in terms of the size of net assets. For bond funds, it varied depending on the research period. Results of funds located on adjacent positions in the ranking turned out to be similar

to each other. When determining fund similarity, greater variation in performance emerged during the pandemic period, as indicated by more clusters and greater distances between bonds in the second period for equity funds. For bond funds in the pandemic period, slightly larger distances between bonds in period two are evident with a similar number of clusters. There are also more one-element clusters in period 2.

Analysing the funds in terms of return and risk separately, therefore, gives an incomplete picture of their assessment. Even the created ranking of funds in which the values of funds are very close to each other does not give such a possibility. Similarity analysis is able to broaden this assessment by combining these variables with each other. This allows, among other things, the investor to optimise the portfolio accordingly by selecting funds with minimal risk at an acceptable rate of return.

Cluster analysis can also be used to decide whether to invest in a single fund. Similar funds from a given cluster generate similar results, so the investor may then pay attention to other elements, e.g. costs, in order to invest in a fund with lower fees. It is also worth looking for clusters within a given group that differ from the others. Such funds often have a different investment policy, which may yield higher results.

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