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Assessment of the performance persistence of Employee Capital Plans

Abstract

Estimating the future return rates is virtually impossible. However, it is possible to verify whether financial institutions that invest entrusted funds are able to maintain high rates of return for a long time. This phenomenon is referred to as performance persistence, and has become the object of interest of the author of this article in relation to Employee Capital Plans (ECP). A research hypothesis was adopted that performance persistence in ECP does occur. It was verified using contingency tables that were created for defined date funds that operate in ECP, using monthly rates of return and the Sharpe index. The results obtained by the author allowed concluding that the performance persistence of rates of return in the case of ECP occurs for a maximum of half of the research period.

1. Introduction

The literature on the subject emphasizes that there is no guarantee of repeating investment results. However, many studies, both Polish and foreign, indicate the occurrence of the phenomenon of repeatability of results, otherwise known as performance persistence. Knowing about its existence can be useful for people who want to increase their savings. The vast majority of research on the subject relates to mutual funds as well as hedge funds. There are relatively few studies on pension funds. In their case, the deposited funds remain under the management of one entity for a long time. The phenomenon of competitive capital supply is much less common in them than, for example, in the case of investment funds. This can

lead to full sustainability of the achieved results. The intended role of Employee Capital Plans (ECP) in providing additional income after the age of 60 justifies careful examination of the results achieved by funds of a defined date.

The ECP that operate in Poland are quasi-obligatory instruments for long-term saving, which can be classified as being on the border between the 2nd and 3rd pillars. They allow the accumulation of funds in accordance with the life-cycle hypothesis, because depending on the age of the participant, the share structure between the equity and debt parts changes depending on the defined-date fund. Undoubtedly, the use of mechanisms recognized in behavioural economics was helpful in the case of ECP, evidenced by the fact that as of October 31, 2022, 2.48 million people used them (PFR Portal PPK, 2022, 3). In the case of other forms, i.e. the Individual Retirement Account, the Individual Retirement Security Account and Employee Pension Schemes, it was respectively: 797,100 people (as of June 30, 2022), 463,200 people (as of June 30, 2022) and 641, 400 people (as of December 31, 2021) (KNF, 2022a, 2022b, 2022c).

This article fills the research gap by referring to the rates of return achieved by institutions offering ECP. The main purpose of the article is to verify the occurrence of performance persistence of rates of return in ECP. Based on the study of the literature, the author adopted an a priori research hypothesis that performance persistence in ECP does occur. This is mainly because they are relatively young institutions that have been operating on the financial market for a relatively short time (the first stage was initiated in July 2019). The author was additionally encouraged to adopt the hypothesis by the fact that one of the factors conducive to persistence is the differentiation of fees for the management of entrusted funds.[1] An auxiliary hypothesis was also adopted that the performance persistence is influenced by the structure of assets, which is differentiated in the funds of a defined date. The author's study is primarily of applicational importance, because the answer to the question of whether and for how long the institutions offering ECP are able to maintain the level of rates of return, based on the obtained results, may support the decisions of potential participants regarding saving in ECP. This issue is extremely important, especially from the point of view of people between 18 and 50 years of age who are not ECP participants, who will be subject to the auto-enrollment procedure starting in 2023.

To achieve the adopted goal, tables of conditional numbers were used for subsequent months from July 2020 to October 2022. The analysis used monthly rates of return, as well as Sharpe ratios, calculated for 8 funds of a defined date (2025–2060), which were offered by 19 institutions. The analyses included BPS TFI, which was removed from the register of institutions managing ECP

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[1] The maximum amount of fee that can be charged by institution managing the ECP is 0.5% and an additional 0.1% for the result, for up to 75% of institutions (art. 49 of the Act of November 4, 2018 on Employee Capital Plans, Journal of Laws of 2018 item 2215, hereinafter referred to as the ECP Act).

while PFR TFI began managing the accumulated funds (MojePPK, 2022). The results achieved by Aviva before the merger with Allianz were also analyzed. This decision allowed to avoid survivorship bias in the analysis. In addition, among the research methods used by the author, one can point to a critical analysis of the literature on the subject, as well as measures of descriptive statistics. To calculate the risk-free rate of return, profits from three-month treasury bonds were used.

The article, apart from the introduction, consists of three parts and a summary. The first part presents a review of research on performance persistence, including research on pension funds. Then, the methodology of own research was discussed. The third part presents the results of own research.

2. Performance persistence in literature

We are not able to obtain a full guarantee that the investment results from the past will be repeated on the financial market in the future. That is why it is so important to take performance persistence into consideration. The repeatability of the rates of return achieved by various types of funds has been of interest to researchers since the 1960s (Sharpe, 1966; Jensen, 1968; Carlson, 1970). They initiated a research process that continues to this day around the world and applies to virtually all types of funds that are offered on the financial market.

Already in the 1990s Grinblatt and Titman observed, based on the analysis of data from the turn of the 1970s and 1980s, that historical results that are officially published provide investors with many useful information. They allow them to make appropriate investment decisions which translate into capital allocation processes (Grinblatt and Titman, 1992). Hendricks, Patel, and Zeckhauser presented a theory relating to the retention of results by American funds, which allowed them to maintain their appropriate positions in the rankings, using sports terminology. They proposed that high-performing funds be called *hot hands*, while those at the bottom of the charts were called *icy hands*. The use of such a division allowed them to present two key conclusions. First, it is easier for investors to identify funds that performed worse based on historical data and to assume that they will be at the end of the lists in the future. The second conclusion is that it is more difficult to identify funds that were among the best and will continue this trend in the future (Hendricks, Patel and Zeckhauser, 1993).

The possibility of identifying funds that maintain their performance both above and below the average achieved by the entire surveyed population is also possible if short research periods are chosen. Goetzmann and Ibbotson (1994) showed that using a one-month period makes it possible to determine with great accuracy which fund will be able to repeat its performance in the future.

Performance persistence is not permanent in financial markets. There are studies from various parts of the world whose authors showed that the rates of

return did not persist in the periods they analyzed. An example of such research on Asian markets are the publications of Sehgal and Jhanwar (2008) as well as Lai and Lau (2010). On the other hand, studies relating to European financial markets include, among others: Babalos, Caporale, Kostakis and Philippas (2008), as well as Patena and Żołyniak (2008). Perez (2012) and Aspadarec (2019) conducted research on performance persistence in Polish funds (among others). The latter proposed an original measure to determine the performance persistence of returns — the Absolute Return Index (ARI) (Aspadarec, 2019). Kołodziejczyk states that performance persistence in the rates of return achieved could be observed before the pandemic. In her opinion, however, during the COVID-19 pandemic, i.e. after March 12, 2022, the behaviour of the market reversed (Kołodziejczyk, 2022, 127).

Research on performance persistence is also carried out within pension funds, although there are significantly fewer studies of this kind. Researchers' interest in this area of the financial market has been noticeable since the second half of the 1980s (Ippolito and Turner, 1987; Lakonishok, Shleifer, Vishny, Hart, and Perry, 1992; Coggin, Fabozzi and Rahman, 1993). Most of the obtained results allowed the researchers to conclude that performance persistence occurs in short periods. One can point to the research carried out by Martí-Ballester (2009), who analyzed pension plans in Spain. Similar conclusions were obtained by Berggrun and Jaramillo (2011) who dealt with the rates of return achieved in Colombia. In their analysis of domestic investments made by American pension funds, Bauer, Cremers and Frehen (2010) showed that small funds are able to achieve better results. Andonov, Bauer and Cremers (2012) also analyzed US pension funds. In their opinion, asset allocation, market timing, and selection of securities influence achieving better-than-market results. Gerritsen (2016) showed that the size of the pension fund matters. In his opinion, larger institutions are able to achieve higher rates of return than smaller institutions that compete with them.

The abovementioned study by Lakonishok et al. (1992) found US pension fund stock investments to be inferior to the S&P 500 index. Huang and Mahieu (2012) — though they concluded that larger pension funds performed better — indicated with the z-score indicator that Dutch pension funds are not able to achieve better results than the adopted benchmarks. Among the Polish studies concerning pension funds, the results obtained by Marcinkiewicz (2013) are worth pointing out. She analyzed the performance persistence in Open Pension Funds for the period of 2000–2012. The results indicate that this phenomenon occurred incidentally.

3. Research methodology

To verify the adopted research hypothesis that performance persistence occurs in Employee Capital Plans, the author of the publication used tables of conditional numbers. To create them, funds were divided into 8 funds of a defined date (2025,

2030, 2035, 2040, 2045, 2050, 2055, 2060), which were offered by 19 managing entities. The use of such a division results from the fact that, depending on the participant's age, the shares in the debt and equity parts change (art. 40 of the ECP Act). The adoption of BPS PPK, which was taken over by PFR TFI (MojePPK, 2022), and Aviva, which merged with Allianz, allowed the author to avoid the survivorship bias in the analyses.

In the first stage of the research process, monthly rates of return were determined, calculated as the difference in the value of a participation unit on the last day of a given month to the value on the first day of the month, divided by the value on the first day of the month. In the absence of data, they were supplemented with values from the next day.

$$r = \frac{JR_t - JR_{t-1}}{JR_{t-1}}$$

where
r — monthly rate of return,
JR_t — value of the fund's participation unit at the end of the period,
JR_{t-1} — value of the fund's participation unit at the beginning of the period.

This was done based on data obtained from the website Analizy.pl, which was used to rank the analyzed funds in descending order for each month and divided into "winners" — "W" and "losers" — "L". The dividing point was the average rate of return in a given month. Institutions with above-average returns were counted among the winners. The rest were considered losers. In the next step, the situation of individual funds was compared in the following month, whether they managed to maintain the position from the previous month (WW or LL situation), or whether they changed their position due to the achieved rate of return (WL or LW situation).

A similar procedure was carried out concerning the Sharpe ratio to include the risk aspect in the analysis. The author adopted three-month treasury bonds for analysis, as they are considered a safe instrument. This was done since the cost of their purchase is relatively low (PLN 100) and that they offer a fixed interest rate. This ratio was calculated as the quotient of the difference between the achieved rate of return and the rate of return on a risk-free investment about the standard deviation of the rate of return (Dybał, 2008, 74).

$$S_h = \frac{R - RF}{s}$$

where
S_h —Sharpe ratio,
R — rate of return achieved by the fund in the analyzed period,
RF — the rate of return achieved by the risk-free investment in the analyzed period,
s — standard deviation of the rate of return.

The time range covers the analysis from July 2020 to October 2022. The choice of starting date of the research is largely based on the provisions of the Act. From July 1, 2019, it applies to enterprises employing at least 250 people (art. 134 of the ECP Act). At the same time, the legislator gave entities offering ECP a period of 12 months from the date of registration of the fund to adjust the structure of the investment portfolio (art. 42 of the ECP Act). An additional argument for adopting such a research scope is also the fact that due to the COVID-19 pandemic, the period of application of ECP in enterprises employing at least 50 people was equalized with enterprises employing at least 20 people.

The obtained status (WW, LL, WL or LW) of individual funds in the following periods enabled the author to determine the CPR indicator. It allows us to determine whether the performance persistence of rates of return occurs in the analyzed period. A value above 1 allows us to conclude that the analyzed phenomenon has occurred. On the other hand, a value below 1 makes it possible to conclude that there is no repeatability of the results of returns.

$$CPR = \frac{WW * LL}{LW * WL}$$

where
WW — the number of funds that have been successful in two successive periods,
LL — the number of funds that failed in two successive periods,
LW — the number of funds that changed their result for a better one in two consecutive periods,
WL — the number of funds that changed their result for the worse in two consecutive periods.

At a later stage, the test statistic z was introduced. Its positive values, exceeding the critical value (1.96 for the confidence interval of 5%) allow us to conclude that performance persistence occurs. However, in the case of negative values, below the critical value, it can be concluded that there are changes in the ranking positions (from winner to loser and vice versa).

$$z = \frac{\ln CPR}{\sigma_{lnCPR}} \sim N(0;1)$$

$$\sigma_{lnCPR} = \sqrt{\frac{1}{WW} + \frac{1}{WL} + \frac{1}{LW} + \frac{1}{LL}}$$

The second test that enables the statistical verification of CPR is the χ^2 test of independence. It is used to compare the observed distribution with the expected one. Variable χ^2 is characterized by an asymptotic distribution with one degree of freedom. Its positive value, which reaches a value higher than the critical value (for the confidence interval equal to 5%, it is 3.841) means the rejection of the null hypothesis in favor of the alternative hypothesis, which speaks about the statistically significant performance persistence. It is calculated as follows:

$$\chi^2 = \frac{(WW - D1)^2}{D1} + \frac{(WL - D2)^2}{D2} + \frac{(LW - D3)^2}{D3} + \frac{(LL - D4)^2}{D4}$$

Where

$$D1 = \frac{(WW + WL)(WL + LW)}{N}$$

$$D2 = \frac{(WW + WL)(WL + LL)}{N}$$

$$D3 = \frac{(LW + LL)(WW + LW)}{N}$$

$$D4 = \frac{(LW + LL)(WL + LL)}{N}$$

4. Determining the occurrence of performance persistence in ECP — results of own research

While analyzing performance persistence, an analysis of contingency tables for funds of a defined date was carried out (see: Tables 1–8). Both in the case of monthly rates of return and the Sharpe ratio, based on the CPR ratio, it can be concluded that performance persistence occurs for a maximum of half of the research period. In the case of the Sharpe index, it can be stated that the performance persistence defined by the CPR index is more persistent. The conducted test statistics: z and χ^2 allow us to conclude with a 5% confidence interval about the occurrence of persistence much less often than in the case of the CPR indicator. However, differences between the monthly rates of return and the Sharpe index can also be observed here. As in the case of the latter index, the test statistics more often allowed to confirm the hypothesis and the occurrence of the performance persistence.

When analyzing funds of a defined date, it can be observed that persistence verified by the CPR indicator about monthly rates of return was more frequent in the case of funds 2025 and 2040, and the shortest (only 7 times) in the case of funds 2035, 2045, and 2060. However, in the case of the Sharpe ratio, the variation in the frequency of persitence is not that large — 13 times (with a deviation of 1 in the case of funds 2045 and 2050). The exception are the 2060 funds, for which the phenomenon was observed 9 times.

Comparing the z and χ^2 test statistics for defined date funds, it can be observed that the χ^2 statistic more often allows identifying the occurrence of performance persistence than the z statistic with a 5% confidence interval. Concerning monthly rates of return, it occurs most often in the 2035 funds. However, in the case of the Sharpe ratio, the χ^2 statistic allows us to assume the hypothesis of the existence

of persistence in 5 periods, in the 2030 and 2055 funds. On the other hand, the *z* statistic occurs only in 2 periods, in the 2025 and 2045 funds.

When analyzing the results of the 2025 funds (Table 1), i.e. those investing the most in the debt part, it can be observed that although in the case of monthly rates of return the CPR was above 1 in more than half of the cases, these results were statistically significant only in two months. A similar situation occurred in the case of the Sharpe index.

Table 1. Persistence tests for funds with a defined date of 2025

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	3	3	7	6	0.21	2.55	-1.56	5	6	5	3	**2.00**	0.54	0.73
IX 2020	5	3	6	5	0.50	0.54	-0.73	3	6	3	7	0.86	0.02	-0.16
X 2020	6	6	3	4	**3.00**	1.35	1.15	3	7	6	3	**1.17**	0.02	0.16
XI 2020	4	3	7	5	0.34	1,27	-1.11	4	4	6	5	0.53	0.46	-0.68
XII 2020	9	6	2	2	**13.50**	**6.13**	**2.30**	7	7	2	3	**8.17**	**4.34**	**1.99**
I 2021	4	3	5	7	0.34	1.27	-1.11	4	5	5	5	0.80	0.06	-0.24
II 2021	4	5	5	5	0.80	0.06	-0.24	7	5	5	2	**3.50**	1.57	1.23
III 2021	4	5	5	5	0.80	0.06	-0.24	3	3	4	9	0.25	1.96	-1.37
IV 2021	6	7	3	3	**4.67**	2.55	1.56	5	7	5	2	**3.50**	1.57	1.23
V 2021	7	5	5	2	**3.50**	1.57	1.23	7	7	2	3	**8.17**	4.34	1.99
VI 2021	6	3	4	6	0.75	0.09	-0.30	0	5	5	9	0.00	**6.11**	0.00
VII 2021	5	4	5	5	0.80	0.06	-0.24	3	11	3	2	**5.50**	2.54	1.52
VIII 2021	5	4	5	5	0.80	0.06	-0.24	1	7	6	5	0.23	1.53	-1.18
IX 2021	6	5	4	4	**1.88**	0.46	0.68	4	5	7	3	0.95	0.00	-0.05
X 2021	5	3	6	5	0.50	0.54	-0.73	8	5	3	3	**4.44**	2.36	1.50
XI 2021	7	5	3	4	**2.92**	1.27	1.11	9	4	4	2	**4.50**	2.17	1.43
XII 2021	7	5	4	3	**2.92**	1.27	1.11	6	2	4	7	0.43	0.69	-0.82
I 2022	5	5	3	6	**1.39**	0.12	0.35	5	4	5	5	0.80	0.06	-0.24
II 2022	7	8	3	1	**18.67**	**6.74**	**2.31**	7	4	3	3	**3.11**	1.25	1.10
III 2022	6	5	4	4	**1.88**	0.46	0.68	6	4	3	6	**1.33**	0.09	0.30
IV 2022	7	6	3	3	**4.67**	2.55	1.56	1	2	8	8	0.03	9.02	-2.62
V 2022	6	5	4	4	**1.88**	0.46	0.68	5	5	5	4	**1.25**	0.06	0.24
VI 2022	5	4	5	5	0.80	0.06	-0.24	5	4	5	5	0.80	0.06	-0.24
VII 2022	6	4	5	4	**1.20**	0.04	0.20	5	4	5	5	0.80	0.06	-0.24
VIII 2022	3	1	7	8	0.05	6.74	-2.31	4	5	4	6	0.83	0.04	-0.20
IX 2022	6	4	5	3	**1.60**	0.23	0.48	4	7	3	4	**2.33**	0.75	0.86
X 2022	6	3	4	4	**1.13**	0.01	0.12	4	6	5	2	**2.40**	0.70	0,83
VII 2020	3	3	7	6	0.21	2.55	-1.56	3	6	3	7	0.86	0.02	-0.16

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

In the case of 2030 funds (Table 2), i.e. those indended for people investing their savings who have slightly more time until reaching the age of 60, and at the same time may have a larger share of the equity part, it can be observed that performance persistence was more often observed using the Sharpe index. However, this did not translate into statistical significance, which also allows us to conclude that the analyzed phenomenon is not constant in the case of ECP.

Table 2. Persistence tests for funds with a defined date of 2030

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	4	4	6	5	0.53	0.46	-0.68	3	7	6	3	**1.17**	0.02	0.16
IX 2020	4	4	5	6	0.53	0.46	-0.68	3	4	6	6	0.33	1.35	-1.15
X 2020	5	7	3	4	**2.92**	1.27	1.11	5	6	4	4	**1.88**	0.46	0.68
XI 2020	2	4	7	6	0.19	2.77	-1.61	3	5	5	6	0.50	0.54	-0.73
XII 2020	6	6	4	3	**3.00**	1.35	1.15	5	5	6	2	**2.08**	0.51	0.71
I 2021	4	5	4	6	0.83	0.04	-0.20	6	6	2	5	**3.60**	1.66	1.26
II 2021	5	8	3	3	**4.44**	2.36	1.50	5	6	5	2	**3.00**	1.17	1.06
III 2021	5	7	4	3	**2.92**	1.27	1.11	4	5	4	6	0.83	0.04	-0.20
IV 2021	5	6	4	4	**1.88**	0.46	0.68	3	5	6	5	0.50	0.54	-0.73
V 2021	8	6	4	1	**12.00**	4.87	**2.00**	6	8	2	3	**8.00**	4.23	1.96
VI 2021	5	3	4	7	0.54	0.42	-0.65	0	6	5	8	0.00	4.94	0.00
VII 2021	3	6	4	6	0.75	0.09	-0.30	3	10	4	2	**3.75**	1.56	1.22
VIII 2021	3	4	8	4	0.38	1.03	-1.00	3	6	6	4	0.75	0.09	-0.30
IX 2021	7	4	4	4	**1.75**	0.35	0.59	3	2	8	6	0.13	4.23	-1.96
X 2021	4	4	4	7	0.57	0.35	-0.59	4	4	4	7	0.57	0.35	-0.59
XI 2021	5	4	7	3	0.95	0.00	-0.05	6	6	5	2	**3.60**	1.66	1.26
XII 2021	6	2	5	6	0.40	0.83	-0.90	5	4	4	6	0.83	0.04	-0.20
I 2022	5	4	4	6	0.83	0.04	-0.20	5	3	7	4	0.54	0.42	-0.65
II 2022	5	5	5	4	**1.25**	0.06	0.24	8	5	2	4	**5.00**	2.57	1.55
III 2022	3	4	5	7	0.34	1.27	-1.11	4	6	3	6	**1.33**	0.09	0.30
IV 2022	6	7	4	2	**5.25**	2.77	1.61	3	9	3	4	**2.25**	0.65	0.80
V 2022	4	4	5	6	0.53	0.46	-0.68	3	10	3	3	**3.33**	1.38	1.15
VI 2022	4	3	7	5	0.34	1.27	-1.11	2	13	0	4	0.00	4.84	0.00
VII 2022	6	3	5	5	0.72	0.12	-0.35	1	9	8	1	**1.13**	0.01	0.08
VIII 2022	3	2	6	8	0.13	4.23	-1.96	1	5	5	8	0.13	3.32	-1.68
IX 2022	5	5	5	3	**1.67**	0.28	0.53	3	12	0	3	0.00	7.20	0.00
X 2022	7	3	4	3	**1.75**	0.30	0.54	2	11	3	1	**7.33**	2.44	1.44
VII 2020	4	4	6	5	0.53	0.46	-0.68	3	4	6	6	0.33	1.35	-1.15

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

Increasing the share in equity part does not affect the occurrence of persistence. This is confirmed by the results for subsequent funds. For example, the 2035 funds (Table 3) also maintained performance more often when the Sharpe ratio was used as a measure, but this was not confirmed by statistical testing.

Table 3. Persistence tests for funds with a defined date of 2035

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	4	4	6	5	0.53	0.46	-0.68	4	8	5	2	**3.20**	1.31	1.12
IX 2020	3	4	5	7	0.34	1.27	-1.11	3	4	6	6	0.33	1.35	-1.15
X 2020	3	7	4	5	**1.05**	0.00	0.05	5	6	4	4	**1.88**	0.46	0.68
XI 2020	2	3	9	5	0.13	3.91	-1.88	4	5	5	5	0.80	0.06	-0.24
XII 2020	7	6	2	4	**5.25**	2.77	1.61	6	5	5	3	**2.00**	0.54	0.73
I 2021	5	7	3	4	**2.92**	1.27	1.11	5	6	2	6	**2.50**	0.83	0.90
II 2021	3	6	5	5	0.72	0.12	-0.35	4	7	5	3	**1.87**	0.42	0.65

		Monthly rates of return						Sharpe ratio					
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
III 2021	5	6	5	3	**2.00**	0.54	0.73	3	5	5	6	0.50	0.54	-0.73
IV 2021	4	3	6	6	0.33	1.35	-1.15	3	5	6	5	0.50	0.54	-0.73
V 2021	9	7	2	1	**31.50**	8.93	2.60	7	9	1	2	**31.50**	8.93	2.60
VI 2021	3	4	4	8	0.38	1.03	-1.00	2	7	4	6	0.58	0.28	-0.52
VII 2021	2	8	4	5	0.80	0.05	-0.22	4	9	4	2	**4.50**	2.17	1.43
VIII 2021	2	5	8	4	0.31	1.31	-1.12	4	4	7	4	0.57	0.35	-0.59
IX 2021	4	3	6	6	0.33	1.35	-1.15	4	3	5	7	0.34	1.27	-1.11
X 2021	3	4	5	7	0.34	1.27	-1.11	4	4	6	5	0.53	0.46	-0.68
XI 2021	4	4	7	4	0.57	0.35	-0.59	7	5	4	3	**2.92**	1.27	1.11
XII 2021	3	2	6	8	0.13	4.23	-1.96	5	3	5	6	0.50	0.54	-0.73
I 2022	4	4	6	5	0.53	0.46	-0.68	4	3	6	6	0.33	1.35	-1.15
II 2022	7	6	3	3	**4.67**	2.55	1.56	7	5	4	3	2.92	1.27	1.11
III 2022	4	1	8	6	0.08	4.87	-2.00	4	4	4	7	0.57	0.35	-0.59
IV 2022	4	2	5	8	0.20	2.57	-1.55	3	9	2	5	**2.70**	0.89	0.93
V 2022	4	2	8	5	0.20	2.57	-1.55	3	8	6	2	**2.00**	0.43	0.65
VI 2022	4	2	5	8	0.20	2.57	-1.55	3	8	2	6	**2.00**	0.43	0.65
VII 2022	4	3	7	5	0.34	1.27	-1.11	3	7	7	2	**1.50**	0.15	0.38
VIII 2022	2	2	6	9	0.07	6.13	-2.30	4	5	4	6	0.83	0.04	-0.20
IX 2022	6	8	3	1	**16.00**	5.84	2.17	4	10	0	4	0.00	6.43	0.00
X 2022	4	3	5	5	0.48	0.55	-0.74	3	10	3	1	**10.00**	3.61	1.73
VII 2020	4	4	6	5	0.53	0.46	-0.68	3	4	6	6	0.33	1.35	-1.15

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

Only in the case of 2040 funds (Table 4) it can be observed that persistence measured both by monthly rates of return and the Sharpe ratio occurred equally often. However, the achieved results cannot be considered statistically significant, because in the case of monthly rates of return there was no confirmation of the occurrence of the phenomenon in any of the analyzed months. In the case of using Sharpe's index, statistical significance occurred only once.

Table 4. Persistence tests for funds with a defined date of 2040

		Monthly rates of return						Sharpe ratio					
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	3	5	6	5	0.50	0.54	-0.73	4	8	5	2	**3.20**	1.31	1.12
IX 2020	2	4	6	7	0.19	2.77	-1.61	3	4	6	6	0.33	1.35	-1.15
X 2020	3	8	3	5	**1.60**	0.22	0.47	5	6	4	4	**1.88**	0.46	0.68
XI 2020	1	5	8	5	0.13	3.32	-1.68	4	5	5	5	0.80	0.06	-0.24
XII 2020	6	6	4	3	**3.00**	1.35	1.15	6	5	5	3	**2.00**	0.54	0.73
I 2021	5	7	2	5	**3.50**	1.57	1.23	5	6	2	6	**2.50**	0.83	0.90
II 2021	3	7	5	4	**1.05**	0.00	0.05	4	7	5	3	**1.87**	0.42	0.65
III 2021	5	7	4	3	**2.92**	1.27	1.11	3	5	5	6	0.50	0.54	-0.73
IV 2021	4	7	3	5	**1.87**	0.42	0.65	3	5	6	5	0.50	0.54	-0.73
V 2021	6	5	7	1	**4.29**	1.53	1.18	7	9	1	2	**31.50**	8.93	2.60
VI 2021	5	3	3	8	0.63	0.22	-0.47	2	7	4	6	0.58	0.28	-0.52
VII 2021	4	7	4	4	**1.75**	0.35	0.59	4	9	4	2	**4.50**	2.17	1.43

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2021	4	6	5	4	**1.20**	0.04	0.20	4	4	7	4	0.57	0.35	-0.59
IX 2021	4	6	4	5	**1.20**	0.04	0.20	4	3	5	7	0.34	1.27	-1.11
X 2021	3	6	5	5	0.72	0.12	-0.35	4	4	6	5	0.53	0.46	-0.68
XI 2021	5	4	7	3	0.95	0.00	-0.05	7	5	4	3	**2.92**	1.27	1.11
XII 2021	6	2	5	6	0.40	0.83	-0.90	5	3	5	6	0.50	0.54	-0.73
I 2022	6	2	6	5	0.40	0.83	-0.90	4	3	6	6	0.33	1.35	-1.15
II 2022	8	4	3	4	**2.67**	1.03	1.00	7	5	4	3	**2.92**	1.27	1.11
III 2022	2	3	5	9	0.13	3.91	-1.88	4	4	4	7	0.57	0.35	-0.59
IV 2022	2	6	6	5	0.40	0.83	-0.90	3	9	2	5	**2.70**	0.89	0.93
V 2022	3	4	7	5	0.34	1.27	-1.11	3	8	6	2	**2.00**	0.43	0.65
VI 2022	4	2	7	6	0.19	2.77	-1.61	3	8	2	6	**2.00**	0.43	0.65
VII 2022	5	2	6	6	0.28	1.66	-1.26	3	7	7	2	**1.50**	0.15	0.38
VIII 2022	2	3	5	9	0.13	3.91	-1.88	4	5	4	6	0.83	0.04	-0.20
IX 2022	4	8	4	2	**4.00**	1.80	1.31	4	10	0	4	0.00	6.43	0.00
X 2022	4	5	4	4	**1.25**	0.05	0.23	3	10	3	1	**10.00**	3.61	1.73
VII 2020	3	5	6	5	0.50	0.54	-0.73	3	4	6	6	0.33	1.35	-1.15

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

The analysis of the 2045 funds (Table 5) showed that performance persistence occurred most often — as many as 15 times — when the Sharpe index was used for the calculations. However, the tests (χ^2 and z) confirm the statistical significance of the phenomenon only twice. When using monthly rates of return, it can be observed that persistence occurred less often, but in no given month was it statistically significant.

Table 5. Persistence tests for funds with a defined date of 2045

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	2	6	7	4	0.43	0.69	-0.82	4	8	5	2	**3.20**	1.31	1.12
IX 2020	2	4	6	7	0.19	2.77	-1.61	3	4	6	6	0.33	1.35	-1.15
X 2020	4	9	2	4	**4.50**	2.17	1.43	5	6	4	4	**1.88**	0.46	0.68
XI 2020	0	3	10	6	0.00	9.74	0.00	3	6	4	6	0.75	0.09	-0.30
XII 2020	6	7	2	4	**5.25**	2.77	1.61	6	8	4	1	**12.00**	**4.87**	**2.00**
I 2021	5	8	3	3	**4.44**	2.36	1.50	5	7	2	5	**3.50**	1.57	1.23
II 2021	4	6	5	4	**1.20**	0.04	0.20	3	6	6	4	0.75	0.09	-0.30
III 2021	5	5	5	4	**1.25**	0.06	0.24	4	6	4	5	**1.20**	0.04	0.20
IV 2021	4	4	5	6	0.53	0.46	-0.68	4	4	7	4	0.57	0.35	-0.59
V 2021	6	6	4	3	**3.00**	1.35	1.15	7	4	4	4	**1.75**	0.35	0.59
VI 2021	4	5	4	6	0.83	0.04	-0.20	2	4	4	9	0.22	2.17	-1.43
VII 2021	3	5	6	5	0.50	0.54	-0.73	3	9	4	3	**2.25**	0.65	0.80
VIII 2021	6	3	7	3	0.86	0.02	-0.16	3	6	6	4	0.75	0.09	-0.30
IX 2021	4	2	4	9	0.22	2.17	-1.43	3	5	5	6	0.50	0.54	-0.73
X 2021	4	5	6	4	0.83	0.04	-0.20	4	5	6	4	0.83	0.04	-0.20
XI 2021	5	4	5	5	0.80	0.06	-0.24	7	5	4	3	**2.92**	1.27	1.11
XII 2021	5	3	6	5	0.50	0.54	-0.73	5	3	5	6	0.50	0.54	-0.73

	Monthly rates of return						Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
I 2022	4	3	5	7	0.34	1.27	-1.11	3	2	7	7	0.12	4.34	-1.99
II 2022	5	5	5	4	**1.25**	0.06	0.24	7	7	2	3	**8.17**	**4.34**	**1.99**
III 2022	4	3	6	6	0.33	1.35	-1.15	3	4	6	6	0.33	1.35	-1.15
IV 2022	3	4	5	7	0.34	1.27	-1.11	2	8	2	7	**1.14**	0.01	0.12
V 2022	3	2	9	5	0.13	3.91	-1.88	2	10	5	2	**2.00**	0.38	0.61
VI 2022	5	2	5	7	0.29	1.57	-1.23	2	10	2	5	**2.00**	0.38	0.61
VII 2022	5	2	7	5	0.29	1.57	-1.23	2	9	6	2	**1.50**	0.13	0.36
VIII 2022	2	3	4	10	0.15	3.35	-1.74	3	8	3	5	**1.60**	0.22	0.47
IX 2022	5	8	5	0	0.00	5.54	0.00	3	12	0	3	0.00	7.20	0.00
X 2022	3	2	5	7	0.17	2.84	-1.63	2	10	1	4	**5.00**	1.57	1.18
VII 2020	2	6	7	4	0.43	0.69	-0.82	3	4	6	6	0.33	1.35	-1.15

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

The 2050 funds (Table 6), similarly to other ECP defined date funds, are not characterized by a high occurrence of persistence. While using monthly rates of return, it was observed in less than every third observation. It could be demonstrated more often using the Sharpe index, but the statistical tests carried out allow us to talk about the significance of persistence only in December 2020 (while using the Sharpe index).

Table 6. Persistence tests for funds with a defined date of 2050

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	2	7	6	4	0.58	0.28	-0.52	4	8	5	2	**3.20**	1.31	1.12
IX 2020	3	4	7	5	0.34	1.27	-1.11	3	3	7	6	0.21	2.55	-1.56
X 2020	5	7	2	5	**3.50**	1.57	1.23	6	5	4	4	**1.88**	0.46	0.68
XI 2020	1	3	9	6	0.06	6.54	-2.28	3	3	6	7	0.21	2.55	-1.56
XII 2020	6	7	2	4	**5.25**	2.77	1.61	7	7	3	2	**8.17**	**4.34**	**1.99**
I 2021	5	8	3	3	**4.44**	2.36	1.50	6	7	2	4	**5.25**	2.77	1.61
II 2021	4	5	6	4	0.83	0.04	-0.20	3	7	4	5	**1.05**	0.00	0.05
III 2021	4	5	4	6	0.83	0.04	-0.20	3	7	5	4	**1.05**	0.00	0.05
IV 2021	3	7	4	5	**1.05**	0.00	0.05	4	4	7	4	0.57	0.35	-0.59
V 2021	3	5	7	4	0.54	0.42	-0.65	7	4	4	4	**1.75**	0.35	0.59
VI 2021	4	5	4	6	0.83	0.04	-0.20	2	3	5	9	0.13	3.91	-1.88
VII 2021	5	7	4	3	**2.92**	1.27	1.11	3	7	5	4	**1.05**	0.00	0.05
VIII 2021	3	4	6	6	0.33	1.35	-1.15	3	5	6	5	0.50	0.54	-0.73
IX 2021	4	6	4	5	**1.20**	0.04	0.20	3	4	6	6	0.33	1.35	-1.15
X 2021	4	6	5	4	**1.20**	0.04	0.20	3	4	6	6	0.33	1.35	-1.15
XI 2021	4	3	7	5	0.34	1.27	-1.11	6	5	5	3	**2.00**	0.54	0.73
XII 2021	5	3	5	6	0.50	0.54	-0.73	5	3	5	6	0.50	0.54	-0.73
I 2022	4	4	5	6	0.53	0.46	-0.68	3	2	7	7	0.12	4.34	-1.99
II 2022	4	5	5	5	0.80	0.06	-0.24	6	7	2	4	**5.25**	2.77	1.61
III 2022	3	3	7	6	0.21	2.55	-1.56	2	5	6	6	0.28	1.66	-1.26
IV 2022	3	3	6	7	0.21	2.55	-1.56	3	9	2	5	**2.70**	0.89	0.93

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
V 2022	4	3	7	5	0.34	1.27	-1.11	0	14	0	5	0.00	0.00	0.00
VI 2022	4	3	5	7	0.34	1.27	-1.11	0	16	3	0	0.00	0.00	0.00
VII 2022	4	3	7	5	0.34	1.27	-1.11	2	9	7	1	**2.57**	0.53	0.71
VIII 2022	3	3	5	8	0.23	2.36	-1.50	2	8	2	7	**1.14**	0.01	0.12
IX 2022	5	7	4	2	**4.38**	2.10	1.41	2	14	0	2	0.00	7.88	0.00
X 2022	4	2	6	5	0.27	1.63	-1.25	2	11	4	0	0.00	4.16	0.00
VII 2020	2	7	6	4	0.58	0.28	-0.52	3	3	7	6	0.21	2.55	-1.56

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

Although the 2055 funds (Table 7) have one of the greatest possibilities of investing funds in assets from the equity part, in their case there are no significant differences in terms of the occurrence of performance persistence compared to other funds of a defined date. It is important that in the case of monthly returns, there is no confirmation in statistical tests. While using the Sharpe index, both tests confirmed the phenomenon of persistence only in January 2021.

Table 7. Persistence tests for funds with a defined date of 2055

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	1	7	7	4	0.25	1.36	-1.12	5	8	4	2	**5.00**	2.57	1.55
IX 2020	3	5	6	5	0.50	0.54	-0.73	3	4	6	6	0.33	1.35	-1.15
X 2020	5	8	2	4	**5.00**	2.57	1.55	5	5	5	4	**1.25**	0.06	0.24
XI 2020	1	3	9	6	0.06	6.54	-2.28	3	2	7	7	0.12	4.34	-1.99
XII 2020	6	7	2	4	**5.25**	2.77	1.61	7	5	4	3	**2.92**	1.27	1.11
I 2021	5	8	3	3	**4.44**	2.36	1.50	7	7	1	4	**12.25**	4.97	2.02
II 2021	4	6	5	4	**1.20**	0.04	0.20	3	5	6	5	0.50	0.54	-0.73
III 2021	3	6	4	6	0.75	0.09	-0.30	4	6	4	5	**1.20**	0.04	0.20
IV 2021	3	6	6	4	0.75	0.09	-0.30	4	4	7	4	0.57	0.35	-0.59
V 2021	6	5	5	3	**2.00**	0.54	0.73	7	4	4	4	**1.75**	0.35	0.59
VI 2021	5	4	4	6	0.83	0.04	-0.20	3	4	4	8	0.38	1.03	-1.00
VII 2021	5	4	4	6	0.83	0.04	-0.20	4	8	4	3	**2.67**	1.03	1.00
VIII 2021	5	5	6	3	**1.39**	0.12	0.35	4	4	7	4	0.57	0.35	-0.59
IX 2021	4	4	4	7	0.57	0.35	-0.59	3	2	6	8	0.13	4.23	-1.96
X 2021	4	6	5	4	**1.20**	0.04	0.20	3	4	6	6	0.33	1.35	-1.15
XI 2021	4	4	6	5	0.53	0.46	-0.68	6	6	4	3	**3.00**	1.35	1.15
XII 2021	5	3	6	5	0.50	0.54	-0.73	5	4	5	5	0.80	0.06	-0.24
I 2022	5	3	5	6	0.50	0.54	-0.73	3	2	7	7	0.12	4.34	-1.99
II 2022	4	6	3	6	**1.33**	0.09	0.30	6	7	2	4	**5.25**	2.77	1.61
III 2022	3	5	7	4	0.54	0.42	-0.65	3	4	7	5	0.34	1.27	-1.11
IV 2022	3	3	6	7	0.21	2.55	-1.56	4	8	1	6	**5.33**	2.04	1.35
V 2022	3	2	8	6	0.13	4.23	-1.96	3	8	6	2	**2.00**	0.43	0.65
VI 2022	5	3	5	6	0.50	0.54	-0.73	2	9	1	7	**2.57**	0.53	0.71
VII 2022	5	3	6	5	0.50	0.54	-0.73	2	10	6	1	**3.33**	0.88	0.91
VIII 2022	3	3	5	8	0.23	2.36	-1.50	2	9	2	6	**1.50**	0.13	0.36

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
IX 2022	4	6	5	3	**1.60**	0.23	0.48	2	14	0	2	0.00	7.88	0.00
X 2022	2	4	6	5	0.27	1.63	-1.25	2	11	4	0	0.00	4.16	0.00
VII 2020	1	7	7	4	0.25	1.36	-1.12	3	4	6	6	0.33	1.35	-1.15

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

Although the last defined date fund under analysis, 2060 (Table 8), has the greatest possibility of investing funds in the shared part (between 60 and 80%), maintaining the results achieved in individual months does not differ significantly from other funds. Here, too, the performance persistence occurred more often when Sharpe's index was used. However, it should be noted that statistical significance was not confirmed in any case after the tests were applied.

Table 8. Persistence tests for funds with a defined date of 2060

	Monthly rates of return							Sharpe ratio						
	WW	LL	LW	WL	CPR	X^2	z	WW	LL	LW	WL	CPR	X^2	z
VIII 2020	1	6	7	5	0.17	2.33	-1.44	5	8	4	2	**5.00**	2.57	1.55
IX 2020	3	4	7	5	0.34	1.27	-1.11	3	3	7	6	0.21	2.55	-1.56
X 2020	5	7	2	5	3.50	1.57	1.23	5	5	4	5	**1.25**	0.06	0.24
XI 2020	2	3	9	5	0.13	3.91	-1.88	1	3	7	8	0.05	6.74	-2.31
XII 2020	7	6	2	4	**5.25**	2.77	1.61	4	5	6	4	0.83	0.04	-0.20
I 2021	5	7	3	4	2.92	1.27	1.11	6	6	3	4	**3.00**	1.35	1.15
II 2021	4	4	7	4	0.57	0.35	-0.59	4	4	6	5	0.53	0.46	-0.68
III 2021	5	4	4	6	0.83	0.04	-0.20	4	4	5	6	0.53	0.46	-0.68
IV 2021	5	7	3	4	**2.92**	1.27	1.11	4	4	6	5	0.53	0.46	-0.68
V 2021	7	5	6	1	**5.83**	2.33	1.44	7	6	3	3	**4.67**	2.55	1.56
VI 2021	6	3	3	7	0.86	0.02	-0.16	4	4	5	6	0.53	0.46	-0.68
VII 2021	4	6	4	5	**1.20**	0.04	0.20	4	7	3	5	**1.87**	0.42	0.65
VIII 2021	5	5	6	3	**1.39**	0.12	0.35	4	2	10	3	0.27	1.56	-1.22
IX 2021	4	4	4	7	0.57	0.35	-0.59	5	1	4	9	0.14	2.90	-1.58
X 2021	4	6	5	4	**1.20**	0.04	0.20	3	4	6	6	0.33	1.35	-1.15
XI 2021	3	4	6	6	0.33	1.35	-1.15	6	5	5	3	**2.00**	0.54	0.73
XII 2021	4	5	5	5	0.80	0.06	-0.24	7	5	3	4	**2.92**	1.27	1.11
I 2022	3	4	6	6	0.33	1.35	-1.15	3	2	7	7	0.12	4.34	-1.99
II 2022	4	6	4	5	**1.20**	0.04	0.20	5	7	2	5	**3.50**	1.57	1.23
III 2022	4	5	6	4	0.83	0.04	-0.20	3	6	6	4	0.75	0.09	-0.30
IV 2022	2	3	6	8	0.13	4.23	-1.96	4	8	2	5	**3.20**	1.31	1.12
V 2022	3	3	8	5	0.23	2.36	-1.50	2	7	6	4	0.58	0.28	-0.52
VI 2022	5	3	5	6	0.50	0.54	-0.73	2	11	0	6	0.00	3.07	0.00
VII 2022	5	2	7	5	0.29	1.57	-1.23	2	11	6	0	0.00	3.07	0.00
VIII 2022	3	1	6	9	0.06	6.54	-2.28	2	9	2	6	**1.50**	0.13	0.36
IX 2022	5	5	5	3	**1.67**	0.28	0.53	2	14	0	2	0.00	7.88	0.00
X 2022	4	2	6	5	0.27	1.63	-1.25	2	11	4	0	0.00	4.16	0.00
VII 2020	1	6	7	5	0.17	2.33	-1.44	3	3	7	6	0.21	2.55	-1.56

Note: Values in bold indicate performance persistence.

Source: own study based on data from Analizy.pl (2.11.2022).

The obtained results indicate that performance persistence in the case of ECP occurs sporadically. The use of statistical tests (χ^2 and z) means that they should be considered statistically insignificant in the vast majority. The division into funds of a defined date — which differ in investment limits — also does not translate into maintaining the achieved results.

5. Conclusions

The a priori research hypothesis, which was adopted based on a critical analysis of the literature on the subject, postulated that performance persistence would occur in ECP. The results obtained in this study lead to the conclusion that it should be rejected. Performance persistence occurred for a maximum of half of the analyzed period, using the CPR ratio, for funds 2025 and 2040 in the case of monthly rates of return. Using the Sharpe ratio to analyze the CPR ratio, it can be concluded that persistence occurs in half of the analyzed cases, with the 2060 funds being the exception. It is also worth noting that the diversification of the structure of assets that occurs in funds of a defined date (different structures in the equity part and the debt part) does not affect performance persistence when analyzing the Sharpe ratio. A greater impact is observable in the context in monthly rates of return, as persistence occurred more often in the case of 2025, 2040, and 2030 funds.

Although the CPR indicator indicated the occurrence of performance persistence, it is worth bearing in mind that in the vast majority of cases the use of the test statistics z and χ^2 does not allow for the assumption that this phenomenon occurs. The applied test statistics with a confidence interval of 5% allow to determine the presence of persistence more often when taking into account the Sharpe index (except for funds 2035). In further studies of ECP performance persistence, it is worth considering the use of other risk-based indicators or models that allow determining the occurrence of persistence, e.g. Fama's model.

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