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Pension Funds in Poland: Efficiency Analysis for Years 1999–2013

A b s t r a c t. The reform of the pension system in Poland took place in 1999, when the one-pillar Pay-As-You-Go system (PAYG) was replaced by the three-pillars system consisting of two mandatory (PAYG and fully funded) pillars and voluntary (funded) one. However problems concerning budget deficit in Poland caused that the Polish government introduced significant changes in distribution of the pension contribution between both mandatory pillars and in the pension funds' portfolio composition in 2011 and 2013. The aim of this study is to analyze the performance of the pension funds operating in Poland in the years 1999–2013. Applying Sharpe and Treynor ratios the study provides evidence that well diversified portfolio protects pensioners' interest better than portfolios constructed due to the new rules.

K e y w o r d s: pension system, pension funds, Sharpe and Treynor efficiency ratios.

J E L Classification: G11, G23, H55, J26, J32.

Introduction

The main ideas of changes in the retirement system consist in heightening the pension age and introducing funded system instead of Pay-As-You-Go system (PAYG). The most frequent reason given in the public policy debate for a funded system is the apparently superior performance of the capital market (in terms of the rate of return on investment it can offer) in comparison to the returns on PAYG pension contributions (Sinn, 2000; Feld-

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stein, 1997). However risk of equity instruments must be also taken into account. By now it is widely accepted in most OECD countries that pension systems and rules need to be changed over time, although these changes vary from country to country.

Ensuring coverage of employees through one or more pension plans is fundamental to fighting income poverty in old age. All OECD countries have set up mandatory or quasi-mandatory pension plans, either public or private, to achieve quasi-universal coverage. However, mostly in low-income countries, there is still a significant share of population not covered by public or national plans.

The age at which workers can retire is the most often discussed component of a pension system. People now live longer thus it is necessary to increase the pension age, and to adjust women's retirement age upwards in line with men's age. Many OECD countries have recently done precisely that since it requires an administrative decision thus it is the easiest element of the pension scheme to change. In effect, the majority of OECD countries will have a retirement age of at least 67 years by the middle of this century.

The high costs of administering private pension plans that are passed on to members have been a policy concern for many OECD countries in recent years, especially in the states where systems are mandatory or quasi-mandatory. However, administrative efficiency is also a policy priority in voluntary plans. High fees discourage workers from joining voluntary plans and make mandatory ones very costly. In fact, cost inefficiencies are a threat to the sustainability and suitability of plans themselves.

Changes in the demographic structure, caused by declining fertility rates and the rise in life expectancy, lead to significant increase of the old-age-dependency ratios[1] in Poland, which required a transformation of the pension system. The main reform[2] was implemented in 1999, introduced a new system consisted of three pillars: two mandatory ones: Pay-As-You-Go pillar (Social Insurance Institution – ZUS) and fully funded pillar (open pension funds – OFE), and a voluntary, funded pillar.

The aim of our research[3] is to analyze efficiency of the private pension funds, which were operating in Poland in the years 1999–2013 and compare

[1] Old-age-dependency ratio is the population age 65 and over divided by population age 15-64 (Eurostat).

[2] Detailed description of the pension reform can be found in Góra and Rutkowski (2000), Hausner (2002) among others.

[3] Research is founded by the grant "Analysis of Open Pension Funds Market as Compared to the Open Investment Funds Market Functioning in Poland" 2013/09/B/HS4/00493 financed by National Science Center.

their performance to the efficiency of constructed benchmarks. We use Sharpe and Treynor ratios evaluated on the basis of monthly returns from the accounting units in the period from August 17, 1999 to October 17, 2013. The analysis is provided for the entire period and separately for the sub-periods when certain market tendency is observed (i.e. bull, bear and neutral market).

1. Changes Concerning Pension Funds

Open pension funds started to operate in Poland in 1999 creating the second mandatory pillar of the "new" pension system. Each person could select only one fund and participants were able to change funds with no charge or penalty after a statutory minimum 12 months period of contribution to a fund. Pension funds operate like other open-end mutual funds i.e. they collect retirement savings from employees and their employers, and invest this money in a wide range of assets. At the beginning, there were 21 OFEs but at the end of 2013 only 13 open pension funds were operating on the Polish market, and one more pension fund diapered from the market after last regulations introduced by the Polish government in 2014. In the years 1999–2013 number of participants as well as value of assets were steadily growing, at the end of December, 2013 there were more than 16.3 millions of participants and value of OFEs' assets exceeded 299 billions PLN[4]. The summary of evolution of OFEs' in Poland is presented in Table 1.

Retirement savings have been created by a contribution of 12.22% of earnings (or 19.52% for employees born between 1949 and 1968 who did not choose funded tier). The contribution was credited to individuals' notional accounts, while 7.3% of earnings were to be transferred to the pension funds, which created the second mandatory pillar[5].

There were strict regulations concerning open pension funds investment in risky assets (in order to protect pension plans' participants). Thus during the worldwide financial crisis the losses of OFE were not as substantial as the ones reported by pension funds in developed countries. However the crisis of 2007–2009 caused some serious problems also in Polish economy. Firstly, open pension funds lost a major part of the profits earned for their members before the crisis. Secondly, slower GDP growth caused the increase of the public deficit and the public debenture in relation to GDP.

[4] http://www.igte.com.pl/files/notowania/Dane_OFE_12_2013.pdf

[5] The ceiling to contributions and pensionable earnings was set at 2.5 times average monthly earnings projected for a given year in the state budget law.

As a result, Poland has been no longer in line with the Maastricht criteria. Therefore, in the years 2011–2013 the Polish government introduced several changes in the pension system.

Table 1. Basic characteristics of OFE in years 1999–2014

Year	Net assets [billion PLN]	Contributions [billion PLN]	Members [million]	accounting unit weighting average [PLN]
1999	2.3	2.3	7.0	n.a.
2000	9.9	7.6	10.3	n.a.
2001	19.4	8.7	10.6	n.a.
2002	31.6	9.5	11.0	15.80
2003	44.8	10.3	11.5	17.58
2004	62.6	11.4	12.0	20.08
2005	86.1	14.0	11.7	23.09
2006	116.6	16.2	12.4	26.88
2007	140.0	17.7	13.1	28.55
2008	138.3	20.5	13.8	24.51
2009	178.6	21.0	14.3	27.88
2010	221.3	22.4	14.9	31.10
2011	224.7	15.1	15.5	29.56
2012	269.6	8.0	15.9	34.39
2013	299.3	10.5	16.4	36.88
2014	153.1	7.7	16.6	38.08

Note: all data are registered in December but from 2014 concerns November; http://www.mpips.gov.pl/ubezpieczenia-spoleczne/ubezpieczenie-emerytalne/skladka-na-ubezpieczenie-emerytalne/, http://www.zus.pl/default.asp?p=2&id=1319&name=of141105.xls.

The first manipulation in the original pension system was made in 2011, when the contribution transferred to pension funds was diminished from 7.3% to 2.3%. The remaining 5% was placed in a special individual sub-account. The share of contributions allocated in the sub-accounts within the Social Security Fund and in the funded scheme was to be changing until 2017, when it was to reach 3.8% and 3.5% (for ZUS and OFE accounts, respectively). However, regulation introduced in 2013 affected this scheme transferring 4.38% and 2.92% of earnings to ZUS and OFE accounts, respectively (affected from 2014).

The new law, which went into affect in February 2014, shifted 51.5% of the assets, held by the OFEs (about 150 billion PLN) to the Social Insurance Institution, including all debt securities issued and guaranteed by the State Treasury. According to the new regulation, pension funds are no longer obligatory and each employee will have four months every four years to decide whether 2.92 percent of their income goes to a chosen private fund or to

ZUS[6]. Overhaul of the pension system also concerned changes in the OFEs' investment portfolio, since private pension funds are no longer allowed to invest in government bonds. That will leave the pension funds with most of their assets held in shares of companies listed on the Warsaw Stock Exchange or abroad, and give them an increasingly peripheral role in the future retirement benefits of Poles.

The government considered the changes (which took place in the years 2011 and 2014) necessary to lower Poland's budget deficit. Many specialists called these changes "*significant step backward*"[7], "*un-privatizing the pension system"* (Hagemejer, 2013) or even "*the most drastic nationalization of private assets since Soviet times",* although Polish Prime Minister Donald Tusk asserted that "*it is no more than a bookkeeping change in the way to handle the public's retirement money*" (Bilefsky and Zurawik, 2013).

After new regulations, at the end of November 2014 the private pension funds equaled only 153.1 billion PLN (in September 2014 it was 159 billion PLN[8]) and it was reported that 2.5 millions of OFE members (only 15.2% of employees) decided to stay in pension funds[9]. Due to Polish Financial Supervision Authority, the value of total contribution transferred to the pension funds in September 2013 was 1050.8 millions PLN compared to 254.3 millions PLN[10] in September 2014. The new regulations introduced in 2014 lead[11] to a change in the composition of assets' portfolios managed by OFEs

[6] For the first time, employees had to decide till the end of July, 2014 if they stay in the private pension fund by filling and sending to ZUS special form, when the form was not sent the employee was automatically excluded from OFE.

[7] David McMillan, chief executive of AVIVA Europe in London, which manages a private pension fund in Poland with 17.5 billion euros in assets (Bilefsky and Zurawik, 2013).

[8] http://www.analizy.pl/fundusze/wiadomosci/17222/aktywa-funduszy-emerytalnych-%28wrzesien-2014%29.html

[9] It is considered as a very good result for OFE since the previous forecasts evaluated that only 5% of employed stay in OFE.

[10] http://www.knf.gov.pl/opracowania/rynek_emerytalny/dane_o_rynku/rynek_ofe/Dane_miesieczne/dane_miesieczne_ofe.html.

[11] New regulations also include the following changes: (1) gradual transfer of each person's retirement funds managed by OFE to ZUS, which will start ten years before reaching retirement age; (2) automatic transfer of retirement contributions to ZUS, instead of OFE, unless an individual OFE member files a declaration (first time-slot will be between 1 April and 31 July 2014) requesting his/her contributions be transferred to OFE; (3) decrease of the maximum fee OFE can charge from contributions from 3.5% to 1.75%; (4) value of certain categories of assets in OFEs portfolio (i.e. investment certificates issued by closed-end funds, units of open-ended funds or specialized open-ended funds, or units issued by foreign collective investment undertakings of the closed or open-ended type) will not be included in the

not only due to the forced transfer of assets to ZUS but also due to new rules applicable to OFE investment activities. According to the Polish Financial Supervision Authority, shares of treasury bonds and equity instruments in the OFEs' portfolios in 2013 were the biggest among all instruments and nearly equal (42% and 43%, respectively).

In addition to the management of the fund, the market conditions determine the performance of the investment portfolio. In the analyzed period (i.e. the years 1999–2013) the situation of the Polish economy (and the financial market) was changing from high rate of the Polish GDP growth and bull market to recession and bear market in Warsaw Stock Exchange (see Figure 1, which contains comparison of rates of return generated by equity market, represented by the Warsaw Stock Exchange index WIG and OFE in investigated years).

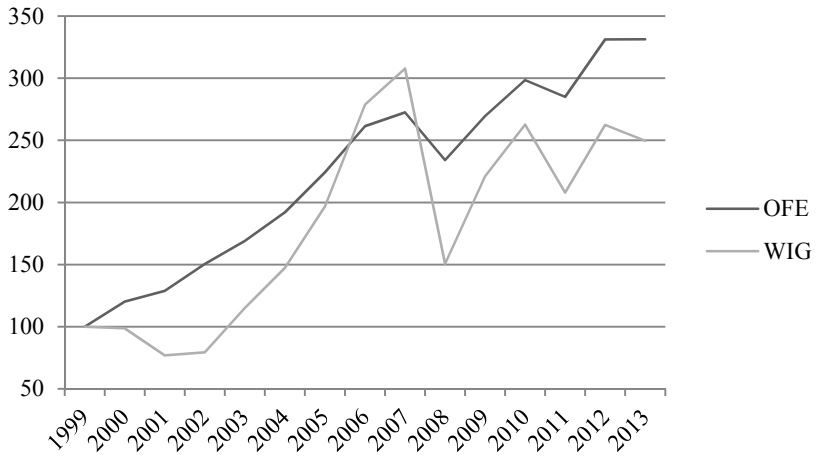

Figure 1. Cumulative annual returns from OFE and WIG in years 1999–2007

Note: to Figure 1. Own evaluation on the basis of http://www.nbp.pl/publikacje/operacje_or/2012/raport2012.pdf and http://www.gpw.pl/analizy_i_statystyki_pelna_wersja.

Another important aspect of the introduced changes is how the pension fund reform will affect the Polish capital market since the increasing capitalization of pension funds made them one of the most important institutional investors generated from 16% to 22% of the Warsaw Stock Exchange turnover among all institutional investors in the years 2005–2010 (Marcinkiewicz,

overall value of total net assets managed by OFE, which means that OFEs may not charge a management fee from these assets.

2011). Smaller contribution to the pension funds will cause the decrease of the investment level. There is also a danger associated with the changes that the risk of investing in Poland has increased.

The private funds hold assets worth about $92 billion, i.e. more than one-fifth of Poland's gross domestic product, and are among the biggest investors on the Warsaw Stock Exchange (Bilefsky and Zurawik, 2013). Also, due to high market concentration, there is a lack of price and investment competition between Open Pension Funds. In 2011, the OFEs' commission equaled 553 millions PLN while wages for management totaled 981 millions PLN[12]. Such situation created broadly critique of pension funds in Poland. As a result of the widespread resentment, Polish government introduced the new pension law. It was estimated that the transfer of 51.5% of OFEs' assets would lead to a decrease of public debt in Poland from around 55% GDP to 47% GDP. This is the main short-term purpose of the reform, rather than providing improved financial security for retirees (Mrowiec and Mruk-Zawirski, 2014).

2. Methodology and Data Applied in Research

The aim of the research is to analyze performance of the private pension funds. The investigation is provided for the accounting units of eleven private pension funds that have been operating in Poland from August 17, 1999 to October 17, 2013. These open pension funds contain 85% of all pension funds' members and 88% net assets (Table 2). Comparison of analyzed funds at the end of July in the years 2013 and 2014 shows that position of particular pension funds on the market did not change however the values of accounting units and 3-year returns increased in 2014 in comparison to the previous year. Values of the accounting units are quite similar and the range is only 5.8 and 6.4 PLN in 2013 and 2014 (i.e. 16.5% and 17.8% of average, respectively). The weighted average of accounting units increased by 2.3% in 2014 in comparison to 2013. Rates of return exhibit more variation since the range is about 32% of the weighted average in both years and they increased in average by 23.8% in 2014 in comparison to returns obtained in the previous year.

[12] See Forbes (2012).

Table 2. Main characteristics of the analyzed pension funds measured on July, 31, 2013 and 2014

Pension funds names	Percentage share of the market				Accounting unit [PLN]		3-year rates of return [%]		Total returns [%]
	Members		Net assets						
	2013	2014	2013	2014	2013	2014	2013	2014	2015
AEGON	5.81	5.62	4.24	4.26	33.56	34.56	15.27	18.68	260.1
ALLIANZ	3.43	4.01	3.04	3.08	33.18	33.99	19.13	21.22	254.9
AVIVA	16.49	16.05	22.38	22.29	34.25	35.16	17.23	19.95	266.6
AXA	7.17	6.97	6.27	6.32	34.40	35.32	16.29	19.62	270.1
GENERALI	6.23	6.05	5.03	5.02	35.90	36.39	14.76	19.45	279.9
ING	18.83	18.45	23.99	23.98	37.63	38.31	17.98	21.79	295.1
NORDEA	5.48	5.98	4.52	4.55	36.39	37.32	19.05	24.28	291.1
PEKAO	2.11	2.05	1.50	1.51	32.74	33.47	14.64	18.71	244.6
POCZTYLION	3.67	3.56	1.90	1.88	31.83	31.91	13.77	17.53	234.4
PZU	13.73	13.40	13.42	13.40	34.74	35.68	15.38	19.61	265.6
WARTA	1.92	2.50	1.34	1.35	35.33	36.04	16.82	20.34	292.3
Total	84.87	84.64	87.63	87.64	35.15*	35.95*	16.64**	20.60**	

Note: Total returns denotes rate of return from the whole period i.e. from the first day of the pension fund operating till Jan. 29, 2015; * denotes weighted averages in considered period, ** weighted averages evaluated for the period 31.03.2010–29.03.2013, and 31.03.2011–31.03.2014, respectively (http://www.igte.com.pl/files/notowania/Dane_OFE_07_2013.pdf).

The first stage of the research is statistical analysis of 6-months sub-periods. In the second stage, we consider daily registered monthly logarithmic rates of return from the accounting units in the entire period of analysis and five sub-periods due to the situation on the Warsaw Stock Exchange i.e. stock index WIG daily quotations:

17.09.1999–20.11.2003 stagnation 1 (1055 observations),
21.11.2003–06.07.2007 bull market 1 (912 observations),
07.07.2007–17.02.2009 bear market (403 observations),
18.02.2009–18.07.2011 bull market 2 (609 observations),
19.07.2011–17.10.2013 stagnation 2 (564 observations).

Sharpe and Treynor ratios are evaluated for all pension funds and their performance is compared to the efficiency of constructed benchmarks. Treasury Bonds represent the risk free instrument.

Portfolios performance usually is measured by comparing their rates of return and risk measures. The former seem to be the most important for the pension funds participants when they select the pension funds. Our study tests several hypotheses in order to find out if the expected value of the analyzed rates of return and their variances significantly differ from the benchmarks. We start from verifying the hypothesis if expected returns differ from zero:

$$H_0 : E(R_p) = 0 \tag{1}$$

using well-known test statistics:

$$u = \frac{\overline{R}_p}{S_p}\sqrt{T}. \tag{2}$$

To test the significance of differences between expected rates of return generating by pension funds and the benchmarks:

$$H_0 : E(R_p) = \overline{R}_B \tag{3}$$

we employ the following test statistics:

$$u = \frac{\overline{R}_p - \overline{R}_B}{S_p}\sqrt{T}, \tag{4}$$

where: $E(R_p)$ – expected rate of return of the analyzed open pension fund, $\overline{R}_p$, $\overline{R}_B$ – average rates of return of the analyzed portfolio and the benchmark, S_p – standard deviation of rates of return generated by the pension fund, T – number of observations, u is normally distributed statistics.

In the next step we test equality of the pension fund's and benchmark's variances. The null hypothesis is:

$$H_0 : D^2(R_p) = S_B^2 \tag{5}$$

and the test statistics is defined as:

$$\chi^2 = \frac{T \cdot S_p^2}{S_B^2}, \tag{6}$$

$$u = \sqrt{2\chi^2} - \sqrt{2(T-1)-1}, \tag{7}$$

where: $D^2(R_p)$ – variance of the portfolio, S_B – standard deviation of rates of return generated by the benchmark, other symbols are described above.

Various researchers who have highlighted numerous factors influencing the portfolio performance have documented investment efficiency. The two

traditional measures of the portfolio performance are the Treynor and the Sharpe indexes[13]:

$$WS_p = \frac{\overline{R}_p - R_f}{S_p}, \tag{8}$$

$$WT_p = \frac{\overline{R}_p - R_f}{\beta_p}, \tag{9}$$

where: WS_p and WT_p – Sharpe and Treynor ratios, respectively, $\overline{R}_p$, R_f – average returns from the analyzed portfolio and the risk free instrument, respectively, β_p – beta coefficient from the single-index model (also called Sharpe's model[14]) estimated separately for each pension fund:

$$R_{pt} = \alpha + \beta_p R_{Bt} + e_t, \tag{10}$$

where: R_{pt}, R_{Bt} – returns from pension funds and benchmark observed in the period *t*.

Significance of beta coefficient, i.e.

$$H_0 : \beta_p = \beta^* \tag{11}$$

can be tested using the test statistics:

$$t = \frac{b_p - \beta^*}{S_{\beta_p}}, \tag{12}$$

where: t – t-Student statistics, b_p – parameter estimates of β, S_{β_p} – standard error, $\beta^* = 0$ or 1.

Ratios (8) and (9) are compared to the efficiency measures evaluated for the constructed benchmarks, WS_B and WT_B. Application of these traditional efficiency measures requires selection of the representative market index and risk-free instrument. We assumed the significance level of 0.05 for all tests.

[13] Sharpe and Treynor ratios are composite measure of portfolio performance that also included risk, for details see: Treynor (1965), Sharpe (1966). Application of Sharpe index to evaluate the private pension funds efficiency is presented in Antolin (2008).

[14] Discussion about Sharpe's model estimated for Polish capital market can be found in Tarczyński et al. (2013) among others.

3. Empirical analysis

In the first stage of research the logarithmic rates of return from of 6-months sub-periods are analyzed. We distinguish 27 such time spans from January 1, 2000 to June 30, 2013 (denoted as P2–P28) and two shorter periods (P1: 17.09.1999–31.12.1999 and P29: 1.07.2013–17.10.2013). P30 denotes the entire period of investigation. For all analyzed pension funds and for hypothetical portfolios rates of return are evaluated.

Table 3a. Rates of returns

No.	End of the period	AEGON	ALL	AVIVA	AXA	GEN	ING	NOREA	POC
P1	31.12.1999	0.0903	0.0764	0.1058	0.0591	0.0628	0.0777	0.0909	0.0796
P2	30.06.2000	0.0755	0.1026	0.0531	0.0981	0.0796	0.0874	0.0502	0.0888
P3	29.12.2000	0.0337	0.0194	0.0471	0.0281	0.0555	0.0591	0.0438	0.0483
P4	29.06.2001	–0.0452	–0.0350	–0.0170	–0.0187	–0.0433	–0.0336	–0.0177	–0.0476
P5	31.12.2001	0.0809	0.1064	0.1131	0.0951	0.1003	0.1072	0.1126	0.0722
P6	28.06.2002	0.0535	0.0643	0.0562	0.0473	0.0543	0.0786	0.0717	0.0388
P7	31.12.2002	0.0693	0.0662	0.0513	0.0485	0.0617	0.0829	0.0669	0.0539
P8	30.06.2003	0.0504	0.0510	0.0428	0.0456	0.0545	0.0547	0.0495	0.0446
P9	31.12.2003	0.0488	0.0545	0.0561	0.0509	0.0591	0.0552	0.0600	0.0578
P10	30.06.2004	0.0423	0.0452	0.0399	0.0553	0.0506	0.0351	0.0361	0.0455
P11	31.12.2004	0.0848	0.0608	0.0814	0.0865	0.0859	0.0863	0.0779	0.0816
P12	30.06.2005	0.0536	0.0487	0.0655	0.0572	0.0580	0.0702	0.0540	0.0520
P13	31.12.2005	0.0663	0.0525	0.0738	0.0701	0.0763	0.0764	0.0678	0.0789
P14	30.06.2006	0.0374	0.0580	0.0441	0.0410	0.0568	0.0453	0.0454	0.0599
P15	29.12.2006	0.0995	0.0900	0.0971	0.1049	0.1086	0.1066	0.0964	0.0979
P16	29.06.2007	0.1018	0.1102	0.1076	0.1062	0.0918	0.0951	0.1047	0.0967
P17	28.12.2007	–0.0484	–0.0479	–0.0429	–0.0480	–0.0381	–0.0475	–0.0548	–0.0579
P18	30.06.2008	–0.0904	–0.0841	–0.0936	–0.0823	–0.0855	–0.0932	–0.0807	–0.0810
P19	31.12.2008	–0.0449	–0.0363	–0.0642	–0.0445	–0.0510	–0.0565	–0.0498	–0.0468
P20	30.06.2009	0.0294	0.0226	0.0147	0.0283	0.0377	0.0213	0.0252	0.0292
P21	31.12.2009	0.0932	0.0953	0.0990	0.0922	0.0961	0.0994	0.0865	0.0879
P22	30.06.2010	0.0138	0.0174	0.0206	0.0201	0.0173	0.0221	0.0271	0.0210
P23	31.12.2010	0.0779	0.0843	0.0846	0.0750	0.0692	0.0877	0.0842	0.0822
P24	30.06.2011	0.0185	0.0266	0.0212	0.0205	0.0196	0.0261	0.0256	0.0183
P25	30.12.2011	–0.0689	–0.0742	–0.0704	–0.0560	–0.0618	–0.0734	–0.0671	–0.0824
P26	29.06.2012	0.0466	0.0547	0.0533	0.0439	0.0459	0.0550	0.0596	0.0471
P27	28.12.2012	0.1011	0.1059	0.0955	0.0906	0.0901	0.0934	0.1025	0.0912
P28	28.06.2013	–0.0206	–0.0123	–0.0110	–0.0083	–0.0123	–0.0052	0.0008	–0.0039
P29	17.10.2013	0.0760	0.0765	0.0803	0.0737	0.0789	0.0850	0.0796	0.0813
P30	17.10.2013	1.1671	1.2454	1.2501	1.2213	1.2681	1.3210	1.2669	1.1773

Note: description of abbreviations: ALL means ALLIANZ, GEN – GENERALI, POC – POCZTYLION.

Considered returns generated by pension funds in analyzed intervals (Tables 3a and 3b) we notice that in general all of them show similar per-

formance. Negative returns are observed only in the following periods: 02.01.2001–29.06.2001, 29.06.2007–31.12.2008, 01.07.2011–30.12.2011, and 02.01.2013–28.06.2013 (except NORDEA in the period P28).

Table 3b. Rates of returns

No.	End of the period	PEKAO	PZU	WARTA	Average	Bond	WIG	WIBOR
P1	31.12.1999	0.0669	0.0738	0.1101	0.0814	–0.0071	0.0921	0.4291
P2	30.06.2000	0.0611	0.0663	0.0648	0.0751	0.0112	0.0342	–0.1283
P3	29.12.2000	0.0187	0.0300	0.0793	0.0425	–0.0102	–0.0904	0.0793
P4	29.06.2001	–0.0228	–0.0291	–0.0575	–0.0336	–0.0196	–0.2369	–0.1942
P5	31.12.2001	0.1131	0.1223	0.0774	0.0999	–0.0265	0.0072	–0.2891
P6	28.06.2002	0.0312	0.0648	0.0536	0.0561	0.0000	0.0140	–0.2609
P7	31.12.2002	0.0379	0.0752	0.0433	0.0600	0.0324	0.0138	–0.2663
P8	30.06.2003	0.0471	0.0532	0.0524	0.0497	0.0359	0.1061	–0.2586
P9	31.12.2003	0.0538	0.0604	0.0664	0.0567	–0.1041	0.2790	0.0187
P10	30.06.2004	0.0673	0.0486	0.0635	0.0479	–0.0505	0.1173	0.0721
P11	31.12.2004	0.0836	0.0814	0.0788	0.0809	0.1059	0.1086	0.1144
P12	30.06.2005	0.0495	0.0570	0.0548	0.0566	0.0800	0.0590	–0.2648
P13	31.12.2005	0.0604	0.0670	0.0750	0.0697	–0.0267	0.2183	–0.0933
P14	30.06.2006	0.0708	0.0479	0.0598	0.0513	–0.0284	0.1201	–0.1102
P15	29.12.2006	0.1174	0.1092	0.0992	0.1025	0.0276	0.2125	0.0000
P16	29.06.2007	0.1423	0.1097	0.0966	0.1055	–0.0249	0.2550	0.1189
P17	28.12.2007	–0.0759	–0.0457	–0.0630	–0.0517	–0.0188	–0.1651	0.1805
P18	30.06.2008	–0.0963	–0.1033	–0.0904	–0.0893	–0.0267	–0.2996	0.1507
P19	31.12.2008	–0.0553	–0.0403	–0.0560	–0.0497	0.0608	–0.3968	–0.1176
P20	30.06.2009	0.0236	0.0136	0.0211	0.0243	–0.0183	0.0711	–0.3913
P21	31.12.2009	0.0997	0.1038	0.0960	0.0954	0.0061	0.2646	–0.0053
P22	30.06.2010	0.0201	0.0195	0.0253	0.0204	0.0192	–0.0345	–0.0190
P23	31.12.2010	0.0775	0.0854	0.0766	0.0804	0.0010	0.1876	0.0055
P24	30.06.2011	0.0219	0.0185	0.0235	0.0219	0.0000	0.0085	0.2357
P25	30.12.2011	–0.0788	–0.0748	–0.0685	–0.0704	0.0035	–0.2557	0.0320
P26	29.06.2012	0.0488	0.0474	0.0510	0.0503	0.0050	0.0630	0.0289
P27	28.12.2012	0.0953	0.0937	0.0950	0.0958	0.0082	0.1565	–0.1514
P28	28.06.2013	–0.0109	–0.0047	–0.0093	–0.0088	–0.0084	–0.0724	–0.4126
P29	17.10.2013	0.0845	0.0814	0.0824	0.0800	–0.0047	0.1607	–0.0561
P30	17.10.2013	1.1941	1.2483	1.2485	1.2379	0.0244	1.1593	–1.6368

Similar, to some extend, tendencies can be observed in the bond, equity and money market (Table 3b). Negative returns appear in the mentioned above periods (except WIBOR in P17, P18, and P25 and bonds in P19 and P25). However negative rates of return are observed additionally in following periods: for bond market: P1, P3, P5, P9, P10, P13, P14, P16, P20, P29; for WIBOR: P2, P5–P8, P12–P14, P20–P22, P27, P29 and the entire period of analysis P30. WIG generates negative returns in P22. To summarize,

among 29 considered sub-periods, pension funds generated negative returns in 6 periods, WIG in 8, bonds in 14 and WIBOR in 16 periods.

Table 4. The structure of the hypothetical portfolios

Asset representative	Structure of the portfolios OFE due to		
	The regulation from		Kompa & Wiśniewski (2014)
	1997	Dec., 6, 2013	
	PORTFOLIO 1	PORTFOLIO 2	PORTFOLIO 3
Bond market: Treasury Bonds	42%	–	30%
Equity market: WIG	46%	79%	70%
Monetary market: WIBOR	12%	21%	–

To analyze efficiency of the pension funds we construct three hypothetical portfolios employing aggregate measures of equity, money and bond markets. They are represented by WIG (Warsaw Stock Exchange Index), WIBOR (Warsaw Interbank Offered Rate) and Treasury Bonds, respectively. These portfolios, are treated as market benchmarks in evaluation of the pension funds performance. The idea of the portfolio structures (presented in Table 4) is to illustrate changes concerning the structure of the pension fund portfolios due to regulations from 1997 and 2013. The first portfolio is constructed due to the regulation from 1997[15], the second one – due to the regulation from Dec. 6, 2013[16] while the third one is the optimal portfolio structure, which was simulated by Kompa, Wiśniewski, (2014), Kompa, (2014) assuming that the portfolio contains only two types of assets.

Next we test hypotheses that expected returns obtained in 6 months periods are significantly different from zero (Table 5). The analysis is provided for selected pension funds and three benchmarks. The positive expected rates of return are denoted by "+", negative by "–", and blank cells denote the situation when the null hypothesis could not be rejected at the significance level 0.05. As one can notice most funds generated positive returns in the majority of periods. There are only 4 periods when all pension funds and created portfolios generated loses, i.e. from July 1, 2007 to December 31, 2008 and from July 1, to December 31, 2011. In fact, pension funds performed better than constructed benchmarks.

[15] File:///D:/Katalogi%20robocze/archiwum%20Dorota/Rok%202014/OFE/Ustawa%20o%20OFE.pdf.

[16] http://orka.sejm.gov.pl/opinie7.nsf/nazwa/1946_u/$file/1946_u.pdf.

Table 5. Verification hypothesis of expected returns (1)–(2)

No.	Port.1	Port.2	Port.3	AEG	ALL	AVI	AXA	GEN	ING	NOR	PEK	POC	PZU	WAR
P1	+	+		+	+	+	+	+	+	+	+	+	+	+
P2	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P3	–	–	–					+	–				+	+
P4	–	–	–							+			+	
P5	–	–		+	+	+	+	+	+	+	+	+	+	+
P6			+	+	+	+	+	+	+	+	+	+	+	+
P7	–	–		+	+	+	+	+	+	+	+	+	+	+
P8	+		+	+	+	+	+	+	+	+	+	+	+	+
P9	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P10	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P11	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P12	+			+	+	+	+	+	+	+	+	+	+	+
P13	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P14		+	+	+	+	+	+	+	+	+	+	+	+	+
P15	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P16	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P17	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P18	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P19	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P20			+	+	+	+	+	+	+	+	+	+	+	+
P21	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P22	+			+	+	+	+	+	+	+	+	+	+	+
P23	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P24	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P25	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P26				+	+	+	+	+	+	+	+	+	+	+
P27	+	+	+	+	+	+	+	+	+	+	+	+	+	+
P28	–	–		+	+	+	+	+	+	+	+	+	+	+
P29	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Note: description of abbreviations: Port.1 – Portfolio1, Port.2 – Portfolio2, Port.3 – Portfolio3, AEG – AEGON, ALL – ALLIANZ, AVI – AVIVA, GEN – GENERALI, NOR – NORDEA, PEK – PEKAO, POC – POCZTYLION, WAR – WARTA.

The conclusion is supported by the tests (3)–(4) and (5)–(7) in the whole analyzed period (i.e. for P30). Table 6 demonstrates that returns from the pension portfolios exceed benchmarks, and variances of all portfolios are smaller than the benchmarks' ones. Therefore, it can be concluded that the open pension funds investment policy was relatively well established. That type of analysis is also provided for the all sub-periods P1–P29. Results presented in Table 7 indicate "+" if value of expected returns or variance generated by pension funds is higher than the ones obtained from benchmarks; "–" the opposite situation and "0" – when null hypotheses cannot be rejected. In general, majority of the OFEs' performance was not worse than constructed portfolios. Expected returns of pension funds are significantly higher than

returns generated by considered benchmarks in 59% of cases for the portfolio 1, in 47% of cases for the portfolio 2, and in 42% of cases in comparison to the last benchmark. For all pension funds, variance of returns (that describe risk) is significantly smaller than the one estimated for the portfolios 2 and 3 while in comparison with variability of returns of the portfolio 1 it is usually smaller.

Table 6. Values of the test statistics

Hypotheses	$H_0 : E(R_p) = E(R_B)$			$H_0 : D^2(R_p) = o_0^2$		
	Portfolio no.			Portfolio no.		
	1	2	3	1	2	3
AEGON	13.58	10.06	5.87	–29.86	–51.17	–46.86
ALLIANZ	14.96	11.43	7.22	–30.01	–51.27	–46.97
AVIVA	13.73	10.50	6.65	–24.98	–48.21	–43.51
AXA	14.60	11.10	6.87	–29.96	–51.24	–46.93
GENERALI	14.65	11.30	7.30	–27.27	–49.60	–45.08
ING	13.82	10.81	7.22	–20.70	–45.6	–40.57
NORDEA	15.12	11.62	7.46	–29.47	–50.94	–46.59
POCZTYLION	12.78	9.52	5.62	–25.69	–48.65	–44.00
PEKAO	13.28	9.97	6.02	–26.51	–49.14	–44.56
PZU	14.07	10.76	6.81	–26.44	–49.10	–44.51
WARTA	13.57	10.38	6.57	–24.29	–47.79	–43.04

Table 7. Comparison of expected returns and risk in analyzed periods P1–P29

Hypotheses	$H_0 : E(R_p) = E(R_B)$									$H_0 : D^2(R_p) = o_0^2$								
	Portfolio no.									Portfolio no.								
	1			2			3			1			2			3		
	+	–	0	+	–	0	+	–	0	+	–	0	+	–	0	+	–	0
AEGON	16	6	7	14	11	4	11	13	5	0	28	1	0	29	0	0	29	0
ALLIANZ	17	7	5	14	10	5	14	13	2	0	26	3	0	29	0	0	29	0
AVIVA	15	5	9	14	11	4	12	13	4	0	25	4	0	29	0	0	29	0
AXA	16	7	6	14	11	4	11	13	5	0	28	1	0	29	0	0	29	0
GENERALI	17	6	6	15	11	3	11	12	6	0	26	3	0	29	0	0	29	0
ING	17	5	7	13	11	5	14	13	2	2	23	4	0	29	0	0	29	0
NORDEA	17	4	8	13	10	6	13	14	2	0	28	1	0	29	0	0	29	0
POCZTYLION	18	6	5	14	11	4	11	12	6	1	26	2	0	29	0	0	29	0
PEKAO	20	7	2	13	11	5	12	13	4	0	26	3	0	29	0	0	29	0
PZU	17	3	9	13	11	5	13	13	3	0	28	1	0	29	0	0	29	0
WARTA	19	5	5	13	11	5	13	12	4	1	25	3	0	29	0	0	29	0
Percentage share	59	19	22	47	37	16	42	44	13	1	91	8	0	100	0	0	100	0

In the second stage of our research we investigate daily registered monthly logarithmic rates of return from the accounting units in the entire period of analysis and five sub-periods.

Table 8. Beta estimates

	Pension funds										
	AEG	ALL	AVI	AXA	GEN	ING	NOR	POC	PEK	PZU	WAR
Period	Portfolio no. 1										
S1	0.483	0.483	0.589	0.507	0.578	0.610	0.456	0.595	0.525	0.463	0.610
Bull1	0.645	0.585	0.641	0.626	0.633	0.698	0.651	0.634	0.631	0.671	0.628
Bear	0.600	0.546	0.660	0.585	0.574	0.674	0.607	0.591	0.585	0.660	0.607
Bull 2	0.542	0.539	0.588	0.546	0.584	0.617	0.544	0.555	0.571	0.636	0.578
S2	0.762	0.773	0.765	0.671	0.742	0.783	0.759	0.778	0.797	0.784	0.748
Period	Portfolio no. 2										
S1	0.312	0.315	0.380	0.326	0.375	0.402	0.298	0.386	0.339	0.300	0.390
Bull1	0.405	0.379	0.404	0.395	0.400	0.436	0.415	0.401	0.408	0.426	0.403
Bear	0.359	0.326	0.399	0.350	0.346	0.403	0.365	0.353	0.352	0.396	0.365
Bull 2	0.339	0.335	0.365	0.337	0.363	0.382	0.338	0.344	0.354	0.393	0.359
S2	0.441	0.447	0.443	0.389	0.429	0.453	0.440	0.452	0.462	0.454	0.434
Period	Portfolio no. 3										
S1	0.368	0.371	0.442	0.387	0.438	0.471	0.348	0.454	0.398	0.361	0.456
Bull1	0.465	0.426	0.465	0.450	0.457	0.506	0.472	0.460	0.454	0.484	0.458
Bear	0.435	0.396	0.476	0.424	0.416	0.489	0.439	0.428	0.427	0.476	0.439
Bull 2	0.380	0.372	0.405	0.379	0.405	0.425	0.376	0.387	0.395	0.439	0.400
S2	0.506	0.514	0.507	0.446	0.492	0.523	0.506	0.521	0.532	0.523	0.498

Note: description of abbreviations: S – Stagnation, Bull – bullish market, Bear – bearish market, AEG – AEGON, ALL – ALLIANZ, AVI – AVIVA, GEN – GENERALI, NOR – NORDEA, PEK – PEKAO, POC – POCZTYLION, WAR – WARTA.

Table 9. Sharpe and Treynor ratios: hypothetical portfolios

	Portfolio 1 Ratios		Portfolio 2 Ratios		Portfolio 3 Ratios	
Period	Sharpe	Treynor	Sharpe	Treynor	Sharpe	Treynor
S 1	0.027	0.001	0.026	0.002	0.085	0.005
Bull 1	0.400	0.011	0.456	0.020	0.472	0.019
Bear	–0.565	–0.026	–0.607	–0.045	–0.614	–0.040
Bull 2	0.390	0.012	0.419	0.020	0.413	0.018
S 2	–0.067	–0.002	–0.069	–0.003	0.034	0.001

Note: description of abbreviations: S – Stagnation, Bull – bullish market, Bear – bearish market.

Applying tests (3)–(7) for the time series representing logarithmic returns in distinguished sub-periods: S1 – stagnation 1, Bull1 – bull market 1, Bear – bear market, Bull2 – bull market 2 and S2 – stagnation 2, we found out that pension funds are characterized by smaller risk in all considered sub-periods. While expected returns are significantly smaller than the ones generated by benchmarks only during two bull market periods, although if the portfolio 1 is taken into account also in these sub-periods some of pension funds generated returns insignificantly smaller than the benchmark (AEGON, AVIVA, AXA, GENERALI, ING, POCZTYLION, PZU, WARTA in bull market 1 period, ING and PZU in bull market 2 period), while

PEKAO's returns were significantly higher than portfolio 1 in the bull market 1 period.

Table 10. Sharpe ratios: pension funds

Period	AEG	ALL	AVI	AXA	GEN	ING	NOR	POC	PEK	PZU	WAR
S 1	0.522	0.531	0.494	0.487	0.476	0.463	0.587	0.413	0.394	0.551	0.434
Bull 1	0.548	0.562	0.569	0.607	0.607	0.529	0.527	0.579	0.676	0.561	0.608
Bear	–0.454	–0.460	–0.468	–0.445	–0.457	–0.434	–0.463	–0.461	–0.538	–0.435	–0.497
Bull 2	0.577	0.599	0.565	0.580	0.559	0.561	0.596	0.571	0.579	0.521	0.571
S 2	0.230	0.259	0.249	0.282	0.253	0.260	0.298	0.221	0.236	0.236	0.266

Note: description of abbreviations: S – Stagnation, Bull – bullish market, Bear – bearish market, AEG – AEGON, ALL – ALLIANZ, AVI – AVIVA, GEN – GENERALI, NOR – NORDEA, PEK – PEKAO, POC – POCZTYLION, WAR – WARTA.

Table 11. Treynor ratios for pension funds

portfolio 1 is the market benchmark in the Sharpe model											
Period	AEG	ALL	AVI	AXA	GEN	ING	NOR	POC	PEK	PZU	WAR
S 1	0.025	0.027	0.023	0.024	0.022	0.023	0.029	0.020	0.021	0.028	0.021
Bull 1	0.016	0.017	0.017	0.018	0.018	0.016	0.016	0.017	0.020	0.017	0.018
Bear	–0.022	–0.023	–0.023	–0.022	–0.022	–0.021	–0.023	–0.023	–0.027	–0.022	–0.025
Bull 2	0.018	0.019	0.018	0.018	0.018	0.018	0.019	0.018	0.018	0.016	0.018
S 2	0.007	0.008	0.007	0.008	0.007	0.008	0.009	0.006	0.007	0.007	0.008
portfolio 2 is the market benchmark in the Sharpe model											
Period	AEG	ALL	AVI	AXA	GEN	ING	NOR	POC	PEK	PZU	WAR
S 1	0.038	0.042	0.035	0.037	0.034	0.035	0.045	0.030	0.033	0.043	0.032
Bull 1	0.026	0.026	0.027	0.028	0.028	0.025	0.024	0.027	0.031	0.026	0.029
Bear	–0.037	–0.038	–0.038	–0.037	–0.037	–0.036	–0.038	–0.038	–0.045	–0.036	–0.041
Bull 2	0.030	0.031	0.029	0.030	0.028	0.029	0.031	0.029	0.029	0.027	0.029
S 2	0.012	0.013	0.012	0.014	0.013	0.013	0.015	0.011	0.012	0.012	0.013
portfolio 3 is market benchmark in the Sharpe model											
Period	AEG	ALL	AVI	AXA	GEN	ING	NOR	POC	PEK	PZU	WAR
S 1	0.032	0.036	0.030	0.031	0.029	0.030	0.039	0.026	0.028	0.036	0.028
Bull 1	0.022	0.023	0.023	0.025	0.025	0.022	0.021	0.024	0.028	0.023	0.025
Bear	–0.031	–0.032	–0.032	–0.030	–0.031	–0.030	–0.032	–0.031	–0.037	–0.030	–0.034
Bull 2	0.026	0.028	0.026	0.027	0.025	0.026	0.028	0.026	0.026	0.024	0.026
S 2	0.010	0.011	0.011	0.012	0.011	0.011	0.013	0.010	0.010	0.010	0.012

Note: description of abbreviations: S – Stagnation, Bull – bullish market, Bear – bearish market, AEG – AEGON, ALL – ALLIANZ, AVI – AVIVA, GEN – GENERALI, NOR – NORDEA, PEK – PEKAO, POC – POCZTYLION, WAR – WARTA.

The efficiency of the pension funds is measured using Sharpe and Treynor ratios (8) and (9). To evaluate Treynor ratios three versions of single-index models (10) for each pension fund and every considered sub-period are estimated. These models differ by the market indexes, which are repre-

sented by constructed portfolios. In our research we employ OLS method[17]. The parameter estimates obtained for three hypothetical benchmarks are presented in Table 8, all betas are significantly higher than zero and smaller than one.

Tables 9 and 10 present results that all pension funds are more effective than constructed benchmarks in terms of Sharpe ratios. Treynor measures evaluated for pension funds are higher than the ones calculated for the market benchmarks in all analyzed sub-periods, except bear market for the pension fund PEKAO and portfolios 1 and 2 (Tables 11). In other words, analyses of efficiency measures calculated for the hypothetical portfolios shows that portfolio 3 seems to be the most effective especially in terms of Sharpe ratio.

Conclusions

Demographic structure of the Polish population has been changing that causes the increase of old age dependency ratio from 15.26 in 1989 to 17.75 in 1999, and 19.32 in 2011. Therefore, general reform of the pension system was necessary and it took place in Poland in the year 1999, replacing the Pay-As-You-Go system, by the three-pillars partly funded system. Under the system introduced in Poland in 1999, two pillars were universal and mandatory, and the third one – voluntary. The first pillar remained to be Pay-As-You-Go financed, whereas the second and third pillars were to be funded. In fact, the "old" PAYG system was downsized and converted to a "notional defined-contribution" system, forming the new first pillar governed by the Social Insurance Institution. In both mandatory pillars, contributions were registered in individual accounts, and the pension benefits depended on contributions paid, not contributions that were due.

After the subprime crisis, because of the increase of the budget deficit, Polish government introduced the new regulations in the pension system in 2011 and 2013. The most important move was shifting 51.5% of the assets held by the OFEs to the state-run PAYG pension system – ZUS (affected from February 2014). Other changes consisted in changes in:

– the retirement age (it has been increasing by a month each quarter beginning from the first quarter of year 2013),

[17] Discussion of beta estimation has been provided by many researches all around the world however our previous research shows that OLS method is appropriate to this purpose (see: Tarczyński, Witkowska, Kompa, 2013).

– the share of the contribution of earnings that is saved in both mandatory pillars (affected from May 2011),
– the role of the mandatory funded pillar that became voluntary (affected from August 2014),
– the scheme of investments i.e. the pension funds' portfolio composition, especially prohibition of investing in debt securities issued and guaranteed by the State Treasury (beginning from 2014).

The research, presented in the paper, shows that the performance of pension funds was better than the constructed benchmarks, regardless the general situation in the capital market. It proves that diversified (as it was stated in 1999) portfolio better protects pensioner's interest than portfolios with limited types of financial instruments. It can be noticed also by analyzing accounting units (Table 1), which have been systematically increasing. It proves that new regulations, especially the one concerning structure of the pension funds' portfolios, does not improve the performance of pension funds. In addition lack of debt securities issued and guaranteed by the State Treasury in OFE's investments will increase the risk exposure of retirement savings. New regulations significantly limited the role of the funded pillar in the pension system. There is also a danger that declining of the pension funds assets will significantly influence Polish capital market and the whole economy.

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Fundusze emerytalne w Polsce: analiza efektywności za lata 1999–2013

Z a r y s t r e ś c i. Reforma systemu emerytalnego została wprowadzona w Polsce w 1999r., kiedy repartycyjny system zdefiniowanego świadczenia zastąpiono systemem zdefiniowanej składki, opartym na 3 filarach. Dwa pierwsze filary – repartycyjny i kapitałowy stały się publiczne i obowiązkowe, a trzeci dobrowolny kapitałowy. Jednakże problemy związane ze wzrostem deficytu budżetowego spowodowały wprowadzenie przez rząd istotnych zmian systemu emerytalnego w latach 2011 i 2013. Regulacje te nie tylko w istotny sposób wpłynęły na podział składek przekazywanych do obu obowiązkowych filarów, ale spowodowały zmiany w strukturze portfeli inwestycyjnych otwartych funduszy emerytalnych (OFE). Celem realizowanych badań jest analiza wyników finansowych OFE funkcjonujących w Polsce w latach 1999–2013. Na podstawie mierników efektywności Sharpe'a i Treynora pokazano, że dobrze zdywersyfikowane portfele OFE lepiej chronią interesy emerytów niż portfele hipotetyczne, skonstruowane zgodnie z nowymi zasadami.

S ł o w a k l u c z o w e: system emerytalny, fundusze OFE, wskaźniki Sharpe i Treynora.