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APPLYING THE RISKGRADE MEASURE IN THE RISK ANALYSIS AND THE EFFICIENCY OF OPEN PENSION FUNDS

ABSTRACT. The paper aims at reminding the classic risk measures and presenting the RiskGrade measure (1994). This statistic allows comparisons between the investment risk of different financial assets and also the risk of financial investments across different regions of the World. Some advantages and disadvantages of this measure of volatility and also technical problems of using will be described.

After describing RiskGrade measure, the rating of Open Pension Funds (OPFs) considering the investment risk will be created. Obtained results will be compared with the risk of selected Open Investment Funds (OIFs) – with similar assets structure – operating on the Polish asset's market. Next part of the paper contains the suggestion of the measure of efficiency of investment based on RiskMetrics volatility.

Key words: Risk analysis, RiskGrade measure, Open Pension Funds (OPFs), Evaluation of Investing Efficiency.

I. FACTORS OF INVESTMENT RISK

The most important factor, which needs to be taken into account when investing in financial and capital market is risk. Investment risk applies when realized return (income) rate from investment may differ from return (income) rate expected by an investor. „The risk appears where the activity provokes generating potential benefits or losses, which cannot be forecasted (…). The risk is an objective notion and it may be measured" [see Williams C.A., Smith M. L., Young P. C. (2002)]. The general level of risk in case of OPF's consists of: interest rate risk – result of changing market interest rates, short-term price change of financial assets risk – result of demand and supply of certain financial assets. These two kinds of risk belong to a group of market risk (systematic risk). Next, in terms of importance for OPF's operation, is the group of risk factors connected

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with stocks and shares (non-systematic risk), that is branch risk – connected with investment in securities of certain market segment and company specific risk, result of risk factors specific for the company (risk peculiar to a particular branch). Another type of risk, which is important form the point of view of efficiency, is the risk connected with bad management and wrong decisions of investment advisors who are responsible for fund management and the fluency risk, that is the possibility of realisation or conversion of securities. Finally, there are other less significant types of risk, namely: exchange rate risk, inflation and political risk [see Francis J. C. (2000)].

II. CLASSICAL RISK MEASURES

The commonly known risk measures that are used to analyze OPF's market can be divided into two groups: dispersion measures – based on deviation of expected return rate, and measures defined on the basis of probability.

The first group includes variation and standard deviation (SD) of return rates, which is the most commonly used measure of return rate variability. Semivariation and standard semideviation, which measures average negative deviation of return rates, that is a level of expected return rate, which was not achieved. Beta coefficient of share (fund investment portfolio), which defines the level of dependence of OPF's portfolio rates of return on market portfolio rates of return *(benchmark)*. To analyze OPF's risk one can also use other, less popular measures, such as: coefficient of variation, range, or asymmetry measures.

The second group consists of measures based on probability of fund not obtaining an assumed return rate $p = P(R_{OPF,t} < RFR_t)$, where $R_{OPF,t}$ – fund's return rate during time under investigation t, and RFR_t – assumed return rate from risk-free assets (or mean return rate of the whole funds market) [see Bernstein P.L., Damodaran A. (1999)]. Another measure in this group is Value-at-Risk *(VaR)*. For a given investment portfolio with start value W_0 and end value W_n and a probability α equal to significance level of Value-at-Risk *(VaR)* during time t is a number expressing amount of money fulfilling the inequality $P(W_n - W_0 > VaR) < \alpha$. The α coefficient is interpreted as a probability of realization of portfolio value higher than the value VaR [see Best P. (2000)]. However, these measures are not commonly used due to lack of knowledge of probability distribution of return rates, not sufficient market history and lack of legal regulations obligating its use.

III. RISKGRADE INVESTMENT RISK EVALUATION METHOD

In 1994 J.P. Morgan – the global investment bank – launched RiskMetrics a transparent approach to measuring the risk of financial asset. RiskMetrics quickly became the standard for institutions around the world to measure and manage their financial risk.

The RiskGrade statistic (RG) is a new measure of volatility devised and elaborated by the RiskMetrics Group, to help investors understand their market risk better. RiskGrade measurements are based on exactly the same data and analysis as RiskMetrics Value-at-Risk estimates and, in fact, can be translated back into *VaR* estimates. However, the RiskGrade measure is scaled, to be more intuitive and easier to use than *VaR*. RiskGrade is measured on a scale from 0 to 1000 or more, where 100 corresponds to the average RiskGrade value of major equity market indices during normal market condition. RiskGrade allows comparison between investments. The RiskGrade measure is a standardized measure of volatility, and therefore allows collation of investment risk across all asset classes and regions. It is consistent, dynamic and global, and it operates differently from traditional risk measures, such as beta and standard deviation.

As a measure of volatility RiskGrade is similar to the two previously mentioned popular risk measures. Standard deviation is a general statistical measure of volatility. It can be used to measure dispersion from the mean of any data series, such as a time series of returns. However, there are two main differences between these measures. The first is that RiskGrade estimates are based on exponential weighting of historical data, which makes them more adaptive to current market condition than plain standard deviation. The second difference is that RiskGrade has been calibrated to be made easier to interpret for the general public. Standard deviation, however, does not have such an intuitive reference point: we can easily say that a standard deviation of 5% represents more risk than 2%, but it's not obvious how risky that is.

Beta coefficient measures how much an individual stock or (funds' portfolio) is likely to move, with general market (benchmark). Beta can be used to compare the systematic risks of various stocks (portfolios), but has several limitations which are rooted in its parent theory of *The Capital Asset Pricing Model (CAPM)*. Firstly, it is only a relative risk measure: beta is only a measure how a stock (funds' portfolio) is likely to move relative to an overall stock index (benchmark), and gives no indication of the stock's (benchmark) unique volatility. Beta coefficient can be misleading because two stocks (portfolios) with the same beta generally have a different unique risk. Secondly, it only measures incremental systematic risk for a perfectly diversified portfolio. Thirdly, CAPM focuses only on the risk premium of equities relative to risk-free-assets; it does not address fixed income and currency investments, and consequently, it is difficult to apply across asset classes. To sum up, we can say that RiskGrades account for both systematic and unique risk and thus show the whole picture of risk. RiskGrade measure itself has the limitation of being based only on historical market data. It is not a Crystal Ball that can forecast hidden risks.

RiskMetrics volatilities are calculated by using an exponentially weighted moving average, where the latest observations carry the highest weight in the volatility estimate. The exponentially weighted volatility for asset i at time t estimate can be written as:

$$\hat{\sigma}_{i,t} = \sqrt{(1-\lambda)\sum_{j=0}^{\infty} \lambda^j r_{i,t-j}^2}, \tag{1}$$

where λ is the decay factor. The rate of return $r_{i,t}$ of asset i at time t is one-day logarithmic return computed by $r_{i,t} = \ln(P_{i,t} / P_{i,t-1})$, where $P_{i,t}$ denotes the price of asset i at time t.

Given that we do not have an infinitely long history of returns, we need to define a cut-off point. The criterion for defining the cut-off is to use as many returns as necessary to incorporate 99% of the information contained in an infinitely long history of returns. We can formalize this idea by observing that the total weight of an infinitely long history is equal to $1/(1-\lambda)$, whereas the weight of a finite series consisting of n returns is equal to $(1-\lambda^n)/(1-\lambda)$. Therefore, to incorporate 99% of the weight, we need to set $n = \ln(0{,}01)/\ln(\lambda)$. Note that, the effective number of observations used in the volatility estimate depends on the decay factor λ – the higher the decay factor, the higher the number of observations. Hence, the actual RiskMetrics volatility $(RMv_{i,t})$ estimate is:

$$\hat{\sigma}_{i,t} = \sqrt{\frac{1-\lambda}{1-\lambda^n}\sum_{j=0}^{n} \lambda^j r_{i,t-j}^2}. \tag{2}$$

Equation (3) presents the formula used to calculate the RiskGrade (RG) of asset i:

$$RiskGrade(i) = \frac{RMv_{i,t}}{\hat{\sigma}_{base}} \times 100 \Rightarrow RG_i = \frac{\hat{\sigma}_{i,t}\sqrt{252}}{\hat{\sigma}_{base}} \times 100, \tag{3}$$

where $\hat{\sigma}_{i,t}$ and $\hat{\sigma}_{base}$ denote the RiskMetrics volatility of asset i and base volatility (annualized market volatility)[1] respectively [see Kim J., Mina J. (2000), www.riskgrade.com].

The methodology described above is used to estimate permanently the variance of a single financial asset. As fund's return rates are calculated on the basis of value of their account unit, it can be used to analyze OPFs and OIFs portfolios risks [see www.riskmetrics.com].

IV. RISKGRADE RESULTS

The table below shows the risk of OPFs and selected OIFs (with similar assets structure) in 2001-2005. Base (annual) volatility for the market portfolio $(RiskGrade_{base})$ in this time was calculated by the formula below where elements are nominal rates of return as follows: WIG index, treasury bonds, 1M WIBID (Warsaw Interbank Bid Rate), DAX (blue-chip index of Deutsche Börse), FTSE–100 (100 blue-chip companies of the UK market) and DJIA (Dow Jones Industrial Average, Index of the New York Stock Exchange). Market portfolio consisted of 65% bonds, 30% shares, 4% interbank deposits and 1% foreign investments. In this case volatility of the equity indices in the international group was intentionally not used, as the purpose was to compare risk inside a narrow group of investment and pension funds in Poland. The base volatility in a given period was $\hat{\sigma}_{base} = 9,96\%$, corresponding to $RG = 100$.

In 2001 the most aggressive policy among pension funds was run by Bankowy OPF – it was the only fund with investment risk higher than the base volatility (111,6). As from 2002 the highest risk among pension funds was taken by ING N-N Polska OPF (from 43,5 to 79). Whereas the least risky fund was: in 2001 AIG OPF (46,5), in 2002 and 2003 Pekao OPF (30,8 and 53,5), and since 2004 OPF Allianz Polska (36,3). Among the group of steady rise funds the most risky investments were made by PIONEER StabW OIF (RG statistic varied from 47,5 to 96,4), and as from 2002 the most passive investing was made by SEB4 Stabilnego Wzrostu OIF (RG between 13,6–16,8). Comparing RG value and $RiskGrade_{base}$ it is worth noticing, that risk taken by funds was much smaller than the base volatility. In the years under investigation the risk dropped most at: Bankowy OPF, PIONEER StabW OIF and SEB4 Stabilnego Wzrostu OIF. The biggest rise of the risk was at PZU OIF MAZUREK.

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[1] Annualized market volatility denote the annualized market-cap weighted average volatility. It is the average of the volatilities of the equity indices with market-cap weights. The market-cap weights are based on capitalization of each market. It is not the volatility of the global equity portfolio, which is composed of market-cap weighted indices.

Table 1

RiskGrade results for OPFs and OIFs in a years 2001–2005

No.	OPF and OIF	Risk-Grade 2001 *(annual)*	Place	Risk-Grade 2002 *(annual)*	Place	Risk-Grade 2003 *(annual)*	Place	Risk-Grade 2004 *(annual)*	Place	**Risk-Grade 2005 *(annual)***	**Place**
1	ING N-N Polska OPF	74,7	7	62,0	2	79,0	1	43,5	3	**49,9**	**1**
2	PIONEER StabW OIF	96,4	2	82,4	1	78,5	2	44,1	2	**47,5**	**2**
3	SKARBIEC III Filar	78,0	5	58,1	4	76,7	3	45,0	1	**47,2**	**3**
4	OPF PZU	62,8	14	53,8	9	68,2	13	43,1	5	**46,5**	**4**
5	CU OPF BPH CU WBK	69,4	11	56,8	5	68,8	11	39,7	13	**46,4**	**5**
6	Nordea OPF (SAMPO OPF)	76,8	6	54,7	7	68,8	11	39,9	12	**46,4**	**5**
7	PZU OIF MAZUREK	27,9	23	38,3	19	74,5	5	43,3	4	**46,1**	**7**
8	OPF Polsat	51,7	19	40,9	17	67,8	14	37,7	18	**46,0**	**8**
9	ING OIF Stabilnego Wzrostu	68,1	13	52,7	10	72,7	6	38,2	17	**45,6**	**9**
10	AIG OPF	46,5	20	46,5	15	74,6	4	39,1	16	**45,5**	**10**
11	Bankowy OPF	111,6	1	55,8	6	70,2	10	39,4	15	**45,5**	**10**
12	OPF Skarbiec-Emerytura	83,7	3	31,1	21	65,7	17	41,2	8	**45,5**	**10**
13	DWS Emerytalny	58,8	16	51,7	11	41,9	22	29,3	20	**45,1**	**13**
14	OPF Ergo Hestia	55,6	18	50,1	12	71,0	9	40,4	10	**44,9**	**14**
15	Pekao OPF	70,3	10	30,8	22	53,5	20	39,7	13	**44,6**	**15**
16	OPF DOM	73,7	8	54,2	8	63,0	18	41,5	7	**44,5**	**16**
17	Generali OPF	78,3	4	60,2	3	71,5	8	42,6	6	**44,4**	**17**
18	Winterthur OPF (CSL&P OPF)	62,0	15	49,1	13	65,9	16	40,5	9	**43,7**	**18**
19	OPF Pocztylion	70,7	9	48,9	14	66,9	15	40,1	11	**43,3**	**19**
20	PKO/CS Stabilnego Wzrostu	68,7	12	41,8	16	71,7	7	27,7	22	**39,8**	**20**
21	OPF Allianz Polska	56,2	17	40,3	18	61,7	19	36,3	19	**36,5**	**21**
22	Legg Mason SENIOR SOIF	42,7	21	35,3	20	48,2	21	27,8	21	**33,5**	**22**
23	SEB4 Stabilnego Wzrostu OIF	32,2	22	15,7	23	13,7	23	13,6	23	**16,8**	**23**
RiskGrade $_{base}$		100		100		100		100		**100**	

Source: Own elaboration (Funds placed by RiskGrade 2005).

V. EFFICIENCY MEASUERS PROPOSAL

Using the idea of RiskGrade method we can propose a simple long-term investment fund's efficiency measure based on RiskMetrics volatility. In order to do so one has to calculate logarithmic return rates for each OPF during the whole period of time taken under consideration (for monthly data one can include inflation). Using formula (2) we calculate fund's average monthly volatility of the rate of return $\hat{\sigma}^{(m)}_{OPF,t}$ – $\left(RMv^{(m)}_{OPF,t}\right)$. We multiply the obtained result by a square-root of 12, or a square-root of n, in order to obtain an annual value of risk $\left(RMv^{(a)}_{OPF,t}\right)$: $\hat{\sigma}^{(a)}_{OPF,t} = \hat{\sigma}^{(m)}_{OPF,t} \times \sqrt{12}$, or the risk value of the whole period taken under investigation $\left(RMv^{(n)}_{OPF,t}\right)$: $\hat{\sigma}^{(n)}_{OPF,t} = \hat{\sigma}^{(m)}_{OPF,t} \times \sqrt{n}$. We calculate "time-weighted rate of return", which is a product of fund's monthly real logarithmic return rates during the whole period under investigation, according to formula:

$$R^{(n)}_{OPF,t} = \left[\prod_{t=1}^{n}(1+r_t)\right] - 1 = [(1+r_1)\times(1+r_2)\times(1+r_3)\times\ldots\times(1+r_n)] - 1, \qquad (4)$$

where $t = 1,..,n$.

We divide this return rate by n in order to obtain a real monthly average return rate $R^{(m)}_{OPF,t} = R^{(n)}_{OPF,t}/n$, or we multiply it by $12/n$, to obtain a real annual average return rate: $R^{(a)}_{OPF,t} = R^{(n)}_{OPF,t} \times (12/n)$. We calculate a real monthly average and an annual return rate of risk-free assets $RFR^{(m)}_t$ and $RFR^{(a)}_t$. The Real annual efficiency indicators can be written as:

$$IE_{\inf}{}^{(a)}{}_{OPF} = \frac{R^{(a)}_{OPF,t}}{RMv^{(a)}_{OPF,t}} \Rightarrow \frac{R^{(a)}_{OPF,t}}{\hat{\sigma}^{(a)}_{OPF,t}} \Rightarrow \frac{R^{(a)}_{OPF,t}}{\hat{\sigma}^{(m)}_{OPF,t} \times \sqrt{12}} \qquad (5)$$

and including profitability of risk-free assets as:

$$IE_{\inf,RFR}{}^{(a)}{}_{OPF} = \frac{R^{(a)}_{OPF,t} - RFR^{(a)}_t}{RMv^{(a)}_{OPF,t}} \Rightarrow \frac{R^{(a)}_{OPF,t} - RFR^{(a)}_t}{\hat{\sigma}^{(a)}_{OPF,t}} \Rightarrow \frac{R^{(a)}_{OPF,t} - RFR^{(a)}_t}{\hat{\sigma}^{(m)}_{OPF,t} \times \sqrt{12}}. \qquad (6)$$

Similarly, the real efficiency indicators can be calculated for the whole period taken under investigation, which can be written as:

$$IE_{\text{inf}}{}^{(n)}{}_{OPF} = \frac{R_{OPF,t}^{(n)}}{RMv_{OPF,t}^{(n)}} \Rightarrow \frac{R_{OPF,t}^{(n)}}{\hat{\sigma}_{OPF,t}^{(n)}} \Rightarrow \frac{R_{OPF,t}^{(m)} \times n}{\hat{\sigma}_{OPF,t}^{(m)} \times \sqrt{n}}, \tag{7}$$

$$IE_{\text{inf},RFR}{}^{(n)}{}_{OPF} = \frac{R_{OPF,t}^{(n)} - RFR_t^{(n)}}{RMv_{OPF,t}^{(n)}} \Rightarrow \frac{R_{OPF,t}^{(n)} - RFR_t^{(n)}}{\hat{\sigma}_{OPF,t}^{(n)}} \Rightarrow \frac{\left(R_{OPF,t}^{(m)} - RFR_t^{(m)}\right) \times n}{\hat{\sigma}_{OPF,t}^{(m)} \times \sqrt{n}}. \tag{8}$$

In order to compare OPF's results with market portfolio R_{base} formulas (5)-(8) are also used to calculate base efficiency (market portfolio) using corresponding a real monthly and an annual market portfolio characteristics ($R_{base}^{(m)}$, $\hat{\sigma}_{base}^{(m)}$ and $R_{base}^{(a)}$, $\hat{\sigma}_{base}^{(a)}$).

Indicators (5) and (7) inform us of real monthly average fund's return rate per unit of total portfolio risk (expressed in terms of year and the whole period taken under investigation). Whereas indicators (6) and (8) show a real monthly average return rate – above risk-free assets return rate – obtained per unit of total fund's risk (in terms of year and the whole period under investigation).

Suggested methods are based on classic approach for efficiency measuring of investment and they include the risk and return from investments in one coefficient (similar to the Sharpe ratio). Therefore, testing the normal distribution of return rates of OPF's portfolios and market portfolio, which have been used for analysis, seems to be reasonable.

VI. OPF EFFICIENCY

Investment efficiency results for Open Pension Funds from October 1999 to October 2006 (85 samples) are shown in Table 2. Monthly logarithmic return rates of OPF's portfolios and market portfolio R_{base} (including inflation) were used for this analysis. Market portfolio structure was the same as in case of RG risk analysis in Chapter 4 (shares, bonds and interbank deposits of Polish market, as well as foreign market shares). Average annual rate of return for this portfolio was 7,85%, and the volatility – $RMv = 7{,}01$. Normal distribution analysis of rates of return with Shapiro-Wilk test shown that with significance level $\alpha = 0{,}01$, in none of the studied cases (except Bankowy OPF) there was any reason to reject the null hypothesis (H_0), that distribution of rates of return is normal (p>α) [see Domański Cz., Pruska K. (2000)].

All proposed indicators similarly classified the funds unequivocally in terms of investment efficiency. However, these which include interest risk-free assets unambiguously classified pension funds according to their investment efficiency. Comparing results obtained (during the period of time taken under consideration) by all 15 OPFs it is worth noticing, that only top six obtained results better than comparable market portfolio (according to $IE_{\inf,RFR}^{(a)}$ and $IE_{\inf,RFR}^{(n)}$). The leading group was formed by: OPF Polsat (the smallest in terms of assets value) and ING N-N Polska OPF. Average return rates per unit of total OPF risk (over risk-free rate of return) for these funds were twice (or almost twice) as big as the return of market portfolio.

Table 2

OPF investment results based on Time-Weighted Rate of Return for October 1999 – October 2006

No.	OPF	Time-Weighted Rate of Return *(whole period)*	Time-Weighted Rate of Return *(annual)*	Risk-Metrics volatility $RMv_t^{(a)}$ *(annual)*	$IE_{\inf}^{(a)}$ *(annual)*	$IE_{\inf,RFR}^{(a)}$ *(annual)*	$IE_{\inf}^{(n)}$ *(whole period)*	$IE_{\inf,RFR}^{(n)}$ *(whole period)*
1	OPF Polsat	73,76	10,41	7,85	1,33	0,52	3,53	**1,37**
2	ING N-N Polska OPF	68,83	9,72	8,59	1,13	0,39	3,01	**1,04**
3	Generali OPF	65,69	9,27	7,73	1,20	0,38	3,19	**1,00**
4	CU OPF BPH CU WBK	63,47	8,96	7,34	1,22	0,35	3,25	**0,94**
5	OPF PZU	61,20	8,64	8,19	1,05	0,28	2,81	**0,74**
6	OPF DOM	59,12	8,35	8,14	1,03	0,24	2,73	**0,65**
7	Allianz Polska OPF	55,15	7,79	6,74	1,16	0,21	3,08	**0,56**
8	Pekao OPF	56,10	7,92	7,76	0,98	0,20	2,71	**0,54**
9	OPF Pocztylion	56,18	7,93	7,85	1,01	0,20	2,69	**0,53**
10	Nordea OPF (SAMPO OPF)	54,50	7,69	7,89	0,98	0,17	2,60	**0,45**
11	OPF Skarbiec-Emerytura	53,77	7,59	7,82	0,97	0,16	2,58	**0,42**
12	OPF Ergo Hestia	52,31	7,39	7,73	0,96	0,13	2,54	**0,35**
13	Winterthur OPF (CSL&P OPF)	51,79	7,31	7,64	0,96	0,12	2,55	**0,33**
14	Bankowy OPF	48,58	6,86	8,08	0,85	0,06	2,26	**0,16**
15	AIG OPF	48,34	6,82	7,93	0,86	0,06	2,29	**0,16**
R_{base}		55,60	7,85	7,01	1,12	0,21	2,98	0,57
$RFR_t^{(a)}$		×	6,33	×	×	×	×	×

Source: Own elaboration (funds placed by $IE_{\inf,RFR}^{(n)}$ – last collumn).

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Artur Mikulec

ZASTOSOWANIE MIARY RISKGRADE DO ANALIZY RYZYKA I EFEKTYWNOŚCI OTWARTYCH FUNDUSZY EMERYTALNYCH

Celem niniejszego opracowania jest przypomnienie klasycznych miar ryzyka oraz prezentacja miary ryzyka RiskGrade (1994). Statystyka ta pozwala porównywać ryzyko inwestycyjne różnych aktywów finansowych, a także ryzyko inwestycji finansowych pochodzących z różnych regionów Świata. Przedstawione zostaną wady i zalety wspomnianej miary zmienności oraz techniczne problemy jej zastosowania.

Po omówieniu metodologii RiskGrade zbudowany zostanie ranking Otwartych Funduszy Emerytalnych (OFE) pod względem ryzyka inwestycyjnego. Uzyskane wyniki porównane zostaną z ryzykiem wybranych Otwartych Funduszy Inwestycyjnych (OFI) – o podobnej strukturze aktywów – działających na polskim rynku kapitałowym. W kolejnym kroku przedstawiona zostanie propozycja miary efektywności inwestycji opartej na zmienności RiskMetrics.