# THE RISK OF THE POLISH EQUITY FUNDS
# IN THE YEARS 2004-2018 DETERMINED USING
# THE VAR AND CVAR MEASURES

**Dorota Żebrowska-Suchodolska** (iD) https://orcid.org/0000-0003-1230-6413
Faculty of Applied Informatics and Mathematics
Warsaw University of Life Sciences – SGGW, Poland
e-mail: dorota_zebrowska_suchodolska@sggw.pl

**Abstract:** The work analyzed Polish equity funds due to the risk associated with investing in this type of instruments. The study was conducted using risk measures. ie Value at Risk (VaR) and conditional Value at Risk (CVaR). Similarity was measured using the tau-Kendall coefficient.The study examined 15 equity funds that existed in Poland since 2004. The entire research period (2004-2018) was divided into shorter periods ie 2-. 3-. 4- and 5-year periods. The fund rankings based on VaR and CVaR risks gave similar results. In periods of big changes in the economic situation the measures were not able to properly estimate the risk.

## INTRODUCTION

Investment portfolio management is connected with the continuous analysis of changes occurring on the market and correcting the composition of the portfolio. The investor, when entrusting his financial excess institutions of collective investment, decides that such diversification was made by the investment fund managers, of course, within a given type of fund. Often the investor's fear of a potential loss is greater than the prospect of a possible profit. That is why it is so important to focus on the probable risk of loss and to easily calculate it. Such tools are provided by the Value at Risk (VaR) measure. VaR was originally used to evaluate credit risk and then to determine the risk associated with different types of

investments. Increasingly, VaR is also the basis for measures of investment efficiency.

Value at Risk was introduced in 1986 by Ken Garbade of Banker's Trust, when Ken Garbade of Banker's Trust presented a VaR measure calculated for the portfolio of bonds with a different maturity. In the following years, many financial institutions developed the methodology of this measure, presenting various ways of measuring it. Value at Risk was disseminated by JP Morgan, who in 1994 published a model based on the VaR measure. The frequency of applying the Value at Risk was also influenced by the references of the Basel Committee on Banking Supervision, which recommends VaR as a measure of market risk. [Kulczycki 2015].

There is a lot of literature related to the Value at Risk. Many of them deal with risk estimation using different methods and their evaluation due to the results achieved. e.g. [Wiener 1997], [Bohdalova 2007] or [Miletic, Miletic 2015]. VaR estimation for different types of funds can be found, among others in the works [Grau-Carles et al. 2009], [Fedor 2010]. [Weng, Trueck 2011], [Ardia, Boudt 2016], or [Liang, Park 2007]. Research [Grau-Carles et al. 2009] related to monthly returns of 239 UK investment funds over 11 years, from January 1995 to December 2005. Studies focused on risk assessment for loss using Value at Risk (VaR). 10 funds with the highest and lowest monthly rate of return were selected for the research. The results obtained on the basis of the VaR measure and its modifications turned out to be similar. There was also a strong correlation of rankings obtained on the basis of a modified Sharpe index using Value at Risk as a measure of risk. Another VaR estimate can be found in [Tehrani et al. 2014], [Gallali, Guesmi 2008] or [Deb, Barenje 2009]. Tehrani used parametric and non-parametric methods. Gall and Guesmi used a parametric method, historical simulation and Monte Carlo to the portfolios of 14 funds of the Tunisian market. Deb and Barenjee estimated VaR using parametric and non-parametric methods for equity funds of the Indian market.

From Polish literature, it is necessary to mention works on the estimation of Value at Risk for investment funds, i.e. [Olbryś 2009], [Filipowicz 2011], [Rutkowska-Ziarko, Garsztka 2015] or [Rutkowska-Ziarko, Sobieska 2016]. Olbryś calculated VaR for the period 2007-2009 divided into 17 sub-periods. Rutkowska-Ziarko and Sobieska estimated VaR for funds belonging to different risk classes. Filipowicz [2011] evaluated VaR for a portfolio of two equity funds.

The aim of the work is to assess Polish equity funds in terms of risk related to investing in these instruments and answer the question whether it is important to choose the right measure. VaR and CVaR risk measures will be used, which will be analyzed in terms of investment length. The work is the introduction to further research using risk measures to study the effectiveness of investments.

## DATA AND METHODOLOGY OF THE STUDY

Value at Risk (VaR) is the value of a potential loss that will be achieved with a certain probability in a fixed time horizon t [Jajuga 2008]:

$$P(W \leq W_0 - VaR_{\alpha,t}) = \alpha , \qquad (1)$$

where:

$VaR_{\alpha,t}$ - Value at Risk,

$\alpha$ - level of significance,

t - time horizon,

$W_0$ - initial value,

W - value at the end of the period.

If the rates of return are taken into account, the following Value at Risk is used:

$$P(z_t \leq -VaR_{\alpha,t}) = \alpha , \qquad (2)$$

where:

$z_t$ - quantile of the distribution of returns.

One of the methods of estimating Value at Risk is the method of variance-covariance[1], which requires assumption as to the distribution of return rates.

Assuming that the distribution of rates of return is a normal distribution, the Value at Risk is calculated using the formula [Jorion 2006]:

$$VaR = -(r_p + z\delta) , \qquad (3)$$

where:

$r_p$ - average rate of return,

$z$ - a negative value of the quantile of standard normal distribution,

$\delta$ - standard deviation of return rates.

Value at Risk (VaR) can be applied to various types of individual assets as well as portfolios composed of many assets. However, it is not a coherent measure. It is also impossible to use it to estimate the loss value if it exceeds the VaR level [Angelidis, Benos 2008][2]. Based on the negation of the VaR measure, a conditional Value at Risk (CVaR) was created. CVaR is also called Expected Shortfall (ES). It is described by the following relationship:

$$CVaR_{\alpha,t} = E(W \,|\, W > VaR_{\alpha,t}) , \qquad (4)$$

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[1] Other methods are also used, including Monte Carlo method or historical simulation (Kuziak 2003).

[2] In addition, Artzner et al. (1997) gave four axioms that a risk measure must meet.

CVaR estimates the value of the loss that exceeds the VaR level. Assuming that the distribution of rates of return is consistent with the normal distribution, CVaR can be determined from the formula [Albrecht, Koryciorz 2003]:

$$CVaR = r_p - \frac{\varphi_z}{\alpha}\delta , \tag{5}$$

where:

$\varphi_z$ - the density of a standardized normal distribution.

The research concerned 15 equity funds that existed on the Polish market since 2004. These were funds: Aviva Investors Polskich Akcji, Esaliens Akcji, Investor Akcji, Investor Akcji Spółek Dywidendowych, Investor Top 25 Małych Spółek, Millennium Akcji, NN Akcji, Novo Akcji, Pekao Akcji Polskich, PZU Akcji Krakowiak, Rockbridge Akcji, Rockbridge Małych I Średnich Spółek, Santander Akcji, Skarbiec Akcja, UniKorona Akcje. The period 2004-2018 was divided into two-year sub-periods (2004-2005, 2006-2007, 2008-2009, 2010-2011, 2012-2013, 2014-2015, 2016-2017), three-year (2004-2006, 2007-2009 2010-2012, 2013-2015, 2016-2018), four-year (2004-2007, 2008-2011, 2012-2015) and five years (2004-2008, 2009-2013, 2014-2018).
Fund share units values provided the basis for determining the monthly normal returns using the formula:

$$r_t = \frac{p_t - p_{t-1}}{p_{t-1}} , \tag{6}$$

where:
$p_t$ – the value of fund units during the period t.

Values of VaR and CVaR risk measures were estimated at the 0.05 significance level.

In order to answer the question whether the choice of a measure matters, first the Wilcoxon test was verified [Domański 1979].
Having two series of values determined in one sub-period: VaR ($x_i$, $i=1,...,m$) and CvaR ($y_j$, $j=1,..., m$) measures, an ordered sequence is created, consisting of both subseries. Then the elements are sorted in ascending order and give them rank. The value of the statistics is as follows:

$$W = \sum_{i=1}^{m} R(x_i) , \tag{7}$$

where $R(x)$-ranks of the first series.
The value of the statistic (7) is compared with the critical values $W_{\alpha}$ and $E(W)$ for the Wilcoxon test read out for n and m with the adopted level of alpha significance. There is no reason to reject the null hypothesis about the lack of differences between subseries if $W_{\alpha} < W < 2E(W) - W_{\alpha}$. If there is no difference between the series of VaR and CVaR, the coefficient of similarity of tau-Kendall was determined and its significance was examined.

The null hypothesis is that the correlation coefficient of $r_l$ is statistically insignificant to the alternative hypothesis that the correlation coefficient of $r_l$ is statistically significant. A significance level of 0.05 was assumed in the research. Statistica software was used for the research.

## MARKET OF THE MUTUAL FUNDS IN POLAND

The first open-end mutual fund was established in Poland in 1992 (the First Polish American Trust Fund Pioneer), and another one only three years later. From 20 funds in 1997, the number of funds in 2004 increased more than seven times. The development of the investment funds market was influenced by further legal regulations and an increase in investment awareness of Poles.

The Act on Trust Funds of August 28. 1997 changed the terminology of funds (the trust fund was changed into an open-end mutual fund) and gave the fund legal personality. In 1999, the first closed fund was created. The amendment to the Act in 2000 enabled the sale of fund units outside brokerage houses and through individuals. In this year, funds were created that invest outside of Poland and global funds (investing in Poland and abroad). In 2001, the market for bond funds and money market funds developed.

The entry into force of the Act on investment funds in 2004 had a major impact on the current shape of the investment fund market. The adaptation of Polish law to the regulations in force in the European Union unified the principles of fund management, information obligations of open-end funds and the rules for selling shares by foreign funds based in the EU. In 2004, the Chamber of Fund and Asset Management was also set up to carry out activities related to the operation of the funds and the standards of their operation.

At the end of 2004, the net assets of investment funds amounted to 37.43 (PLN bn), and at the end of December, the net asset value of the share-based funds alone was 29.63 (PLN bn). Comparing the Polish and European funds market, the share of fund assets registered in Poland in European Fund assets is small (around 0.5%). However, this is an understandable situation considering the twenty-year period of the capital market functioning and the much shorter development period of the fund market. Nevertheless, despite the small share in the European market, the assets of the funds increase, their share in relation to GDP increases (the exception is the period of the financial crisis), the market structure from the point of view of their division into equity, bonds, money market, etc., reflects the structure of the European market.

## ANALYSIS OF FUNDS DUE TO INVESTMENT RISKS

The average rates of return and standard deviation of the return rates of each fund allowed the VaR to be estimated. Value at Risk results for two-year periods are presented in Table 1.

Table 1. VaR values for equity funds in two-year periods

| Fund | 2004-2005 | 2006-2007 | 2008-2009 | 2010-2011 | 2012-2013 | 2014-2015 | 2016-2017 |
|---|---|---|---|---|---|---|---|
| Aviva Investors Polskich Akcji | 0.036 | 0.082 | 0.154 | 0.089 | 0.042 | 0.050 | 0.031 |
| Esaliens Akcji | 0.044 | 0.074 | 0.135 | 0.071 | 0.055 | 0.058 | 0.029 |
| Investor Akcji | 0.037 | 0.075 | 0.144 | 0.094 | 0.051 | 0.052 | 0.022 |
| Investor Akcji Spółek Dywidendowych | 0.043 | 0.073 | 0.148 | 0.088 | 0.056 | 0.047 | 0.034 |
| Investor Top 25 Małych Spółek | 0.043 | 0.087 | 0.169 | 0.100 | 0.045 | 0.060 | 0.033 |
| Millennium Akcji | 0.050 | 0.077 | 0.130 | 0.086 | 0.053 | 0.052 | 0.041 |
| NN Akcji | 0.047 | 0.078 | 0.136 | 0.095 | 0.060 | 0.046 | 0.045 |
| Novo Akcji | 0.044 | 0.072 | 0.155 | 0.079 | 0.071 | 0.080 | 0.060 |
| Pekao Akcji Polskich | 0.048 | 0.084 | 0.182 | 0.128 | 0.063 | 0.059 | 0.037 |
| PZU Akcji Krakowiak | 0.043 | 0.069 | 0.141 | 0.086 | 0.067 | 0.067 | 0.044 |
| Rockbridge Akcji | 0.037 | 0.077 | 0.135 | 0.089 | 0.059 | 0.056 | 0.043 |
| Rockbridge Małych i Średnich Spółek | 0.058 | 0.107 | 0.162 | 0.089 | 0.049 | 0.053 | 0.036 |
| Santander Akcji | 0.038 | 0.071 | 0.158 | 0.092 | 0.059 | 0.048 | 0.037 |
| Skarbiec Akcja | 0.045 | 0.062 | 0,128 | 0.088 | 0.063 | 0.062 | 0.059 |
| UniKorona Akcje | 0.043 | 0.071 | 0.129 | 0.086 | 0.061 | 0.046 | 0.035 |

Source: own study

The highest loss of investments was observed for the years 2008-2009, ie the period of the financial crisis. It was often four times higher than the value from the period 2004-2005, in which VaR turned out to be the lowest. The highest risk was characteristic for the following funds: Rockbridge Małych i Średnich Spółek (in 2004-2005, 2006-2007). Pekao Akcji Polskich (in 2008-2009, 2010-2011) and Novo Akcji (in 2012-2013, 2014-2015, 2016-2017).

Dividing the whole period of research into three-year sub-periods, the highest VaR values occurred in the 2007-2009 subperiod, and the lowest in the 2004-2006 period. The highest risk was characteristic for the following funds: Rockbridge Małych i Średnich Spółek (in 2004-2006). Pekao Akcji Polskich (in the years 2007-2009, 2010-2012) and Novo Akcji (in the years 2013-2015, 2016-2018). Among the four-year sub-periods, the largest loss of value occurred in 2008-2011, and among the five-year sub-period - in 2004-2008. The highest risk was for

funds: Rockbridge Małych i Średnich Spółek (in the period 2004-2007), Pekao Akcji Polskich (2008-2011) and Novo Akcji (2012-2015).

In the next step, CVaR values were determined in 2-. 3-. 4- and 5-year periods. All CVaR values turned out to be higher than VaR, both for two-year periods as well as for the remaining years studied. This is justified by the definition of this measure. The largest loss in two-year sub-periods was noted, similarly to the Value at Risk, in the period 2008-2009 (CVaR values were between 0.16 to 0.23) and the lowest loss in the period 2004-2005. Slightly lower loss values than for the period 2008-2009 were observed for the years 2007-2009, which turned out to be the period with the highest values in the three-year periods. Of the four-year periods, the largest loss was recorded in 2008-2011, when CVaR ranged from 0.13 to 0.19. The highest values in the five-year subperiods occurred in 2004-2008, ranging from 0.11 to 0.15. The highest risk among specific funds in all sub-periods was characterized by the same values as in the case of the VaR measure.

The VaR and CVaR values obtained were the basis for creating rankings in individual sub-periods. Ranking positions created on the basis of Value at Risk for two-year periods are presented in Table 2. The last position was shaded grey, while the first position was grayed out with a frame. Some VaR values turned out to be the same in individual sub-periods. In such cases, the ranking positions were therefore designated as the arithmetic average of the subsequent items.

Table 2. Ranking positions obtained based on VaR determined in two-year periods

| Fund | 2004-2005 | 2006-2007 | 2008-2009 | 2010-2011 | 2012-2013 | 2014-2015 | 2016-2017 |
|---|---|---|---|---|---|---|---|
| Aviva Investors Polskich Akcji | 15 | 4 | 6 | 7 | 15 | 11 | 13 |
| Esaliens Akcji | 6.5 | 9 | 11.5 | 15 | 10 | 6 | 14 |
| Investor Akcji | 13.5 | 8 | 8 | 4 | 12 | 9.5 | 15 |
| Investor Akcji Spółek Dywidendowych | 9.5 | 10 | 7 | 9.5 | 9 | 13 | 11 |
| Investor Top 25 Małych Spółek | 9.5 | 2 | 2 | 2 | 14 | 4 | 12 |
| Millennium Akcji | 2 | 6.5 | 13 | 12 | 11 | 9.5 | 6 |
| NN Akcji | 4 | 5 | 10 | 3 | 6 | 14.5 | 3 |
| Novo Akcji | 6.5 | 11 | 5 | 14 | 1 | 1 | 1 |
| Pekao Akcji Polskich | 3 | 3 | 1 | 1 | 3.5 | 5 | 7.5 |
| PZU Akcji Krakowiak | 9.5 | 14 | 9 | 12 | 2 | 2 | 4 |
| Rockbridge Akcji | 13.5 | 6.5 | 11.5 | 7 | 7.5 | 7 | 5 |
| Rockbridge Małych i Średnich Spółek | 1 | 1 | 3 | 7 | 13 | 8 | 9 |
| Santander Akcji | 12 | 12.5 | 4 | 5 | 7.5 | 12 | 7.5 |
| Skarbiec Akcja | 5 | 15 | 15 | 9.5 | 3.5 | 3 | 2 |
| UniKorona Akcje | 9.5 | 12.5 | 14 | 12 | 5 | 14.5 | 10 |

Source: own study

In division into sub-periods, two-year individual funds in different sub-periods occupied very different positions. The riskiest fund in the years 2004-2005 and 2006-2007 (Rockbridge Małych i Średnich Spółek) in subsequent sub-periods occupied the middle positions and the second half of the ranking. Pekao Akcji Polskich in all sub-periods was at the forefront of the ranking. Similarly, the situation of fund rankings appeared in a longer time horizon, i.e. three-year sub-periods. The extension of the time horizon to both the four- and five-year subperiods did not affect the stability of the results (Table 3).

Table 3. Ranking positions obtained based on VaR determined in four-year and five-year periods

| Fund | 2004-2007 | 2008-2011 | 2012-2015 | 2004-2008 | 2009-2013 | 2014-2018 |
|---|---|---|---|---|---|---|
| Aviva Investors Polskich Akcji | 6 | 5 | 15 | 5 | 11 | 15 |
| Esaliens Akcji | 7 | 15 | 5 | 10.5 | 15 | 13 |
| Investor Akcji | 10 | 7.5 | 13 | 7.5 | 11 | 4 |
| Investor Akcji Spółek Dywidendowych | 8 | 7.5 | 11.5 | 7.5 | 11 | 10.5 |
| Investor Top 25 Małych Spółek | 2 | 2 | 8 | 2 | 6.5 | 6 |
| Millennium Akcji | 4 | 13 | 11.5 | 10.5 | 14 | 7.5 |
| NN Akcji | 5 | 9 | 10 | 9 | 4 | 9 |
| Novo Akcji | 10 | 6 | 1 | 6 | 2 | 1 |
| Pekao Akcji Polskich | 3 | 1 | 4 | 3 | 1 | 7.5 |
| PZU Akcji Krakowiak | 12.5 | 10 | 2 | 12 | 6.5 | 2 |
| Rockbridge Akcji | 10 | 11 | 6 | 13 | 6.5 | 5 |
| Rockbridge Małych i Średnich Spółek | 1 | 3.5 | 14 | 1 | 6.5 | 13 |
| Santander Akcji | 14 | 3.5 | 8 | 4 | 3 | 13 |
| Skarbiec Akcja | 15 | 13 | 3 | 15 | 11 | 3 |
| UniKorona Akcje | 12.5 | 13 | 8 | 14 | 11 | 10.5 |

Source: own study

Rankings obtained on the basis of CVaR were similar to the rankings obtained on the basis of VaR. They differed most often by several positions although there were cases where this difference was higher.
To test the similarity of results, the Wilcoxon test was used first. In all the sub-periods examined, there are no grounds to reject the null hypothesis about the equality of for the considered measures. In the next step, the tau-Kendall coefficient was determined. Similar rankings obtained using measures based on Value at Risk were confirmed by high values of the tau-Kendall coefficient. The values of the coefficient for two-year sub-periods are shown in Table 4.

Table 4. The tau-Kendall coefficient determined in two-year periods

| 2004-2005 | | 2006-2007 | | 2008-2009 | | 2010-2011 | | 2012-2013 | | 2014-2015 | | 2016-2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CVaR$ | | $CVaR$ | | $CVaR$ | | $CVaR$ | | $CVaR$ | | $CVaR$ | | $CVaR$ |
| $VaR$ | 0.956 | $VaR$ | 0.951 | $VaR$ | 0.981 | $VaR$ | 0.939 | $VaR$ | 0.99 | $VaR$ | 0.976 | $VaR$ | 0.995 |

Source: own study

The results obtained indicate a strong similarity between the measures set for two-year sub-periods. A similar situation occurs for the other sub-periods.

## SUMMARY

Considering the results achieved by the funds in terms of their effectiveness, the risk associated with investing in this type of instruments is often forgotten. Analysis of funds due to the risk they achieve is therefore very important from the point of view of the potential loss of the investor. Due to the existence of different types of risk, the work focused on one of it - measures of potential loss, ie VaR and CVaR. Despite the fact that the VaR risk measure is not a coherent measure, the rankings created on the basis of VaR and CVaR give similar results, although CVaR values themselves are higher than VaR.

Earlier author's research on the drawdown measures, which include the Ulcer and Pain indices, showed a similar order of individual sub-periods in terms of the risk being examined [Żebrowska-Suchodolska 2017]. However, in the period of the financial crisis, the average values of maximum decreases were significantly higher than the average VaR or CVaR values. Value at Risk and Conditional Value at Risk, therefore, were not able to overestimate the risks that occurred in that period.

The riskiest funds turned out to be Rockbridge Małych i Średnich Spółek, Pekao Akcji Polskich and Novo Akcji. The research also showed a strong similarity between the measures examined. In all of the sub-periods, the tau-Kendall coefficients turned out to be statistically significant.

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