**Statistical analyses of investment and**

**pension fund’s performances from R. Macedonia**

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**Abstract**

The foundation of the post-modern portfolio theory is creating a portfolio based on the desired target return. This specifically applies on the operations of the investment and pension funds in order to provide a rate of return that meets the payment requirements from the funds’ investors. The preferred targeted return is a return necessary for achieving the desired goal of the investment or pension fund. It is the primary benchmark used to measure performances, dynamic monitoring and evaluation of the risk – return ratio on investment of funds.

The analysis applied in this paper is conducted based on monthly returns of the investment and pension funds from R. Macedonia. It uses the basic, but still highly informative statistical characteristic moments like Skewness, Kurtosis, Jarque – Bera, and Chebyishev’s Inequality.

The objective of this study is trough analyses that use the above and other specific statistical techniques (Sharpe, Sortino, Omega, Upside Potential, Calmar, Sterling) to draw relevant conclusions regarding the risks and the characteristic moments in the performances of the investment and pension funds from the country.

**Keywords:** *desired target return, downside deviation, risks, investments.*

**1. Introduction**

Statistical analyses of the investment and pension funds can serve to review the performances of the funds. Also the statistical analysis can present a potential span of future incomes from the investment of funds' assets. In order to prepare this analysis, we use data for the incomes of investment and pension funds trough the value of their accounting units per month.

This analysis should discover ways to use statistics when analyzing the success rate of investment and pension funds, possible interpretations of certain statistical measures related to risk analysis, and appropriate presentation of certain characteristic points identified during the statistical analysis.

Through statistical analysis of data from a three-year series of monthly returns of the accounting unit at **Ilirika Global**, there were 17 negative returns (with an average of -3.45%), and 19 positive monthly returns (with an average of 1.95%).

Acording to statistical analysis of data from a three-year series of monthly returns of the accounting unit at **Ilirika Southeast Europe**, there were 23 negative returns (with an average of -3,08% %), and 13 positive monthly returns (with an average of 2.30%).

Based on the performed statistical analysis of data from a three-year series of monthly returns of the accounting unit at **Innovo Status Akcii**, there were 23 negative returns (with an average of -2,23%) and 13 positive monthly returns (with an average of 2.07%).

As the statistical analysis shows there were 12 negative returns (with an average of -0,65%), and 24 positive monthly returns (with an average of 0.80%), from a three-year series of monthly returns of the accounting unit at **KB Voluntary Pension Fund**.

At **KB Mandatory Pension Fund,** the statistical analysis of data from a three-year series of monthly returns of the accounting unit presents 11 negative returns (with an average of -0,99%) and 25 positive monthly returns (with an average of 0.92%).

The statistical analysis of **KB Publikum - Balanced** data from a three-year series of monthly returns of the accounting unit shows 17 negative returns (with an average of -1,81%) and 19 positive monthly returns (with an average of 1.50%).

As the statistical analysis shows, there were 15 negative returns (with an average of -0,46%) and 21 positive monthly returns (with an average of 0.84%), data from a three-year series of monthly returns of the accounting unit at **KB Publikum – Bonds.**

Acording to statistical analysis of data from a three-year series of monthly returns of the accounting unit at **KD BRIC**, there were 18 negative returns (with an average of -3.26%), and 18 positive monthly returns (with an average of 2.48%).

Through statistical analysis of data from a three-year series of monthly returns of the accounting unit at **KD South Balkan**, there were 22 negative returns (with an average of -2.22%), and 14 positive monthly returns (with an average of 2.14%).

Based on the performed statistical analysis of data from a three-year series of monthly returns of the accounting unit at **NLB Penzija plus**, there were 13 negative returns (with an average of -0.74%), and 23 positive monthly returns (with an average of 0.91%).

At **NLB Nov Penziski Fond**, statistical analysis of data from a three-year series of monthly returns of the accounting unit presents 11 negative returns (with an average of -0.79%), and 25 positive monthly returns (with an average of 0.88%).



Table 1: Returns from the accounting units of the funds, standard deviation and correlation.

**2. Investment statistics**

**2.1 Absolute Risk Measures**

Standard deviation measures how dispersed returns are around the average. When standard deviation is higher it indicates that returns are spread out over a larger range of values which makes them more volatile. [[2]](#footnote-2)

Investors at times begin a quantitative screening with the statement that they want a “low risk” fund. The connections between risk and standard deviation in the world of traditional investments go way back in history, thus they equate high standard deviation with high risk and also use standard deviation as a comparative statistic, when the truth is that standard deviation is just a statistic that measures predictability.

A high standard deviation means that the fund is volatile, not that the fund is risky or will lose money, while a low standard deviation means a fund is generally consistent in producing similar returns. A fund can have extremely low standard deviation and lose money consistently, or have high standard deviation and never experience a losing period.[[3]](#footnote-3)

When it comes to comparing traditional return analysis and absolute return analysis one of the differences between the two is accepting the fact that volatility is good, provided it is on the upside. By all means, upside volatility should be less of a concern for most investors, who should consider downside deviation as a better measure of a fund’s ability to achieve its return goal. Therefore investors should acquaint themselves with downside deviation. Downside deviation introduces the concept of minimum acceptable return (MAR) as a risk factor. Downside deviation is a modification of the standard deviation such that only variation below a minimum acceptable return is considered. The minimum acceptable return can be chosen to match specific investment objectives.[[4]](#footnote-4)

Downside Deviation =



Table 2: Downside deviation for the accounting units returns of the funds.













Figure 1-11: Distribution of returns of the accounting units of investment and pension funds.

However, in order to determine if the layout of analyzed returns has a distribution that is close to the shape of a normal distribution, it is necessary to conduct a statistical test for normality of the distribution shape. This test helps to determine the possibility that the expected future returns of the accounting units at the investment and pension funds will be in the framework of the normal layout of returns.

The Jarque – Bera test (hereinafter referred to as JB test) as a test for normality of the distributions shape can determine whether the distribution of returns by individual classes of instruments is with a normal distribution or not. The value of the JB test with significance level of 0.10 (confidence level of 90%) must not be greater than 9.21, while the significance level of 0.05 (confidence level of 95%) must not be greater than 5.99. More frequently is used the test with significance coefficient of 0.05.

Test JB=



Table 3: Jarque Bera test for normal distribution of returns in the accounting units of the investment and pension funds

From table 3 we can note that the JB test with significance level of 0.10 meets the layout returns at Ilirika Southeast Europe, Innovo Status Akcii, KB Voluntary Pension Fund, KB Publikum - Bonds, KD BRIC, NLB Penzija plus, NLB Nov Penziski Fond. Therefore relevant conclusions about the layout of future returns by generating a span of possible expectations of returns using standard deviation as a measure of mathematical prediction can be expected in the said investment and pension funds. For the returns of the funds: lirika Global, KB Mandatory Pension Fund, KB Publikum - Balanced, KD South Balkan, mathematical measures for predicting with standard deviation should be taken with caution.

In order to predict future returns we can generate a range of probabilities using the standard deviation as a mathematical measure for predictions of returns and to appropriately generate the possible span of expected returns from the accounting units of the investment and pension funds.



Table 4: Layout of returns from the accounting units of the investment and pension funds within the framework of 1,2 and 3 standard deviations

That would be the case if we base the assumptions on standard normal layout. Considering that in this case we do not have a standard normal layout we can apply the equation of Chebyishev’s Inequality which states that in any set of observations, whether the shape of the distribution is with a normal layout or not, the percentage of observations that lies within k standard deviations is 1-1 / k ^ 2 for each k> 1. In the case of a 2 standard deviation the range is within 75% of the cases around the arithmetic mean or the expected return. In the case of 3 standard deviations we have 89% of the cases.



Table 5: Layout of returns within 2 and 3 standard deviations from the accounting units of investment and pension funds according the Chebyshev’s equation for the absence of normal schedule of distribution.

In order to determine how much do the data deviate from the so-called normal layout it is necessary to make calculations of the moments of dispersion. The programming package MS Excel calculates the coefficient of skewness and the coefficient of kurtosis according to equation (1) and (2).

Adjusted Skewness =

Adjusted Kurtosis =



Table 6: Coefficients of skewness and kurtosis of investment and pension funds from R. Macedonia

When returns fall outside of a normal distribution, the distribution exhibits skewness or kurtosis. Skewness is known as the third “moment” of a return distribution and kurtosis is known as the fourth moment of the return distribution, with the mean and the variance being the first and second moments, respectively. (Variance is a statistic that is closely related to standard deviation; both measure the dispersion of an investment’s historical returns.) Ideally, investors should consider all four moments or characteristics of an investment’s return distribution.

* Skewness: This measure characterizes the degree of asymmetry of a distribution around its mean. Positive skewness indicates a distribution with an asymmetric tail extending toward more positive values. Negative skewness indicates a distribution with an asymmetric tail extending toward more negative values.
* Kurtosis: Kurtosis measures the degree to which a distribution is more or less peaked than a normal distribution. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution. A normal distribution has a kurtosis of 3. Therefore, an investment characterized by high kurtosis will have “fat tails” (higher frequencies of outcomes) at the extreme negative and positive ends of the distribution curve. A distribution of returns exhibiting high kurtosis tends to overestimate the probability of achieving the mean return. Skewness and kurtosis are important because few investment returns are normally distributed. Investors often predict future returns based on standard deviation, but such predictions assume a normal distribution. An investment’s skewness and kurtosis measure how its distribution differs from a normal distribution and therefore provide an indication of the reliability of predictions based on the standard deviation.

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Table 7: Return Distribution Characteristics

* 1. **Absolute Risk-Adjusted Measures**

When it comes to comparing traditional return analysis and absolute return analysis one of the differences between the two is accepting the fact that volatility is good, provided it is on the upside. By all means, upside volatility should be less of a concern for most investors, who should consider downside deviation as a better measure of a fund’s ability to achieve its return goal. Therefore investors should acquaint themselves with downside deviation. Downside deviation introduces the concept of minimum acceptable return (MAR) as a risk factor. The question is, what statistics can we use to compare funds, if we take the standard deviation out of the equation? While fund returns may seem useful, they do not consider the investment’s risk, which is why investors should always use risk-adjusted statistics such as the Sharpe, Sortino, Sterling or Calmar ratios.[[5]](#footnote-5)

The Sharpe ratio is the best-known risk-adjusted statistic. An investment’s Sharpe ratio can be calculated by taking the average period return, subtracting the risk-free rate, and dividing it by the standard deviation for the period.[[6]](#footnote-6)

Sharpe Ratio =



Table 8: Sharpe coefficients for the investment and pension funds in R. Macedonia

Since upside volatility will decrease the Sharpe ratio of some investments, the Sortino ratio can be used as an alternative. The Sortino ratio is similar to the Sharpe ratio; however it uses downside deviation instead of standard deviation in the denominator of the formula, as well as substituting a minimum acceptable return for the risk free rate. In other words, the Sortino ratio equals the return minus the MAR, divided by the downside deviation.[[7]](#footnote-7)

Sortino Ratio =



Table 9: Sortino coefficients for the investment and pension funds in R. Macedonia

The omega ratio is a relative measure of the likelihood of achieving a given return, such as a minimum acceptable return (MAR) or a target return. The probability that a given return will be met or exceeded is greater when the omega value is higher. Omega represents a ratio of the cumulative probability of an investment’s outcome above an investor’s defined return level (a threshold level), to the cumulative probability of an investment’s outcome below an investor’s threshold level. The omega concept divides expected returns into two parts – gains and losses, or returns above the expected rate (the upside) and those below it (the downside). Therefore, in simple terms, consider omega as the ratio of upside returns (good) relative to downside returns (bad).

Where

r is the threshold return, and

F is cumulative density function of returns.[[8]](#footnote-8)

There are several ways to estimate the risk of not achieving a given return, but most of them assume that returns are normally distributed. However, as stated above, investment returns are not normally distributed, as they tend to be skewed or “fat-tailed” (i.e., there are more extreme returns than implied by the theoretical normal distribution). The omega calculations are important as they use the actual return distribution rather than a theoretical normal distribution. Thereby the omega ratio and its components more accurately reflect the historical experience of the investment being measured.

Since omega considers all information available from an investment’s historical return data, it can be used to rank potential investments in a manner specific to the investor’s threshold level. However, the omega decisions are variable for at least two reasons:[[9]](#footnote-9)

* As return information is updated, the probability distribution will change and omega must be updated.
* As an investor’s threshold level changes, the rankings among comparative investments may change.

Consequently, omega allows investors to visualize the trade-off between risk and return at different threshold levels for various investment choices. Note that the omega ratio equals 1 when the threshold is set to the mean of the distribution.

The Omega ratio is a useful investment tool because it can be used in a compact way to show how different investment options relate to a target return and to a MAR.



Table 10: Omega coefficients for the investment and pension funds in R. Macedonia

Because the Sharpe ratio is calculated from return data that has been averaged or annualized, the resulting ranking of the investments do not include higher levels of information specific to the shape of the distribution of the underlying return data. As a result, it is reasonable to conclude that the observed differences in rankings are due to the higher levels of information contained in the Omega calculations. In effect, Omega as a risk-adjusted measure provides investors with additional information to better understand the risk/reward characteristics encapsulated within an investment’s historic returns.

Drawdown analysis can be an excellent way to screen investments. A Maximum Drawdown is the maximum amount of loss from an equity high through the drawdown and back to the point the equity high is reached again. There could be many drawdowns over a given date range and will be listed starting with the maximum drawdown.

The reasons for a drawdown can be numerous, from market stress, giving back part of unrealized profits after a large increase in equity, or to just poor trading. From a quantitative perspective, though, it is important to analyze the reasons that caused a particular drawdown, and not exclude a fund based on just absolute numbers.

The Calmar and Sterling ratios provide additional comparative information for a risk-adjusted assessment of drawdown analysis.[[10]](#footnote-10)

**lirika Global**



**Ilirika Southeast Europe**



**Innovo Status Akcii**



**KB Voluntary Pension Fund**



**KB Mandatory Pension Fund**



**KB Publikum - Balanced**



**KB Publikum - Bonds**



**KD BRIC**



**KD South Balkan**



**NLB Penzija plus**



**NLB Nov Penziski Fond**



Figure 12-23: Calmar and Sterling Ratios of investment and pension funds from R. Macedonia

**3. Conclusion**

Through statistical analysis of data from a three-year series of monthly returns of the accounting unit from the Macedonian investment and pension funds, there were 45,96% negative returns (with an average of -1.79%), and 54,04% positive monthly returns (with an average of 1.53%).

Statistical analysis from Sharpe and Sortino ratios shows that pension funds’ returns are more risk-adjusted than investment funds in the analyzed period.

As for the asymmetry of the returns of accounting units of funds, it can be observed that almost all are negative asymmetrical, which means that they have “fat” tales towards extremely positive and negative values of the distributional curve. In terms of kurtosis they are likewise leptokurtic, which would mean that there is a risk of erroneous estimation of the expected future returns.

The Omega ratios confirms previous indices and presents positive values only in pension funds in terms of the likeness to get the expected returns.

The Kalmar ratios based on data from a three-year series of monthly returns of the accounting unit from investment and pension funds is a good indicator for future downhill events. The bigger the coefficient, the lesser the possibility for the accounting unit to have downward slope. KB Mandatory Pension Fund has good, NLB Penzija plus and NLB Nov Penziski Fond have solid, KB Publikum – Bonds has very good, while KB Voluntary Pension Fund has excellent performance of this indicator.

The indices of traditional portfolio theories are already exhausted when it comes to the latest needs of statistical analyses. The post-modern portfolio theory offers new indices which complete their predecessors so as to attain quality data in the investment decision-making process.

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