

Měření averze ke ztrátě soukromého investora

Measurement of Private Investor's Loss Aversion

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Abstract:

Purpose of the article: This paper gives an empirical view on behaviorance of private investor who is loss averse and whether a loss averse private investor should invest into such risky assets as equity? The main focus is on the use of robust statistical methods and prospect theory for estimation of equity indexes' selected characteristics, mainly risk characteristics. The paper contains a detail discussion, which one risk metric for assets seems suitable for private investor who is loss averse.

Scientific aim of this article: The aim of the article is a critically describe the problems related with private investor's loss aversion behaviorance and how the concept of loss aversion should by applied into equities (or equity indices) investment. The crucial problem is how to measure loss aversion of private investor investing in equities.

Methodology/methods: The primary and secondary research was applied. Selected scientific articles and other literature published with the topic of prospect theory and risk measurement are mainly used to support a critical analyse of how private investor's loss aversion should be define and measured in the reality – in the financial/investment area. Next the primary research was done with selected equity indexes. As the representants of equity indexes were chosen not only "typical" representative as MSCI World index but mainly some derivatives of indexes which track a dividend strategy (indexes comprising stocks of companies that pay dividends).

Findings: Loss averse investor worries about any loss of value of their wealth. If these investors choose to invest in stocks they should prefer to invest in the stock indexes with down-side risk close to zero, respectively those indexes whose down-side risk is lowest among all. This down-risk should by measure with using below-target semivariance. A standard deviation method as a tool for measurement of risk for loss averse investor is not so proper due the fact that large positive outcomes are treated as equally risky as large negative ones. In practice, however, positive outliers should be regarded as a bonus and not as a risk.

Conclusions: A loss averse investors should some part of his/her wealth invest into equity indexes (may be 15%, max.25%). As the best equity index for a loss adverse investor was chosen Natural Monopoly Index 30 Infrastructure Global with the smallest down side risk.

Keywords: Expected utility theory, prospect theory, loss aversion, equity, bootstrap

JEL Classification: D03, G02

Introduction

The cornerstone of the modern theory of decision making under risk is expected utility maximization as elaborated by Bernoulli (1738), Ramsey (1931), von Neumann and Morgenstern (1944) and many subsequent authors. The expected utility maximization is an inherent part of the classical portfolio optimization approach – mean-variance optimization. This approach uses mean-variance analysis as the investment criterion under which investors minimize the variance of the total portfolio return by setting the portfolio expected return to a prescribed target. The standard deviation metrics represents a value of risk in this method. There are many other approaches to measure risk aversion of private investors and by investor's risk profile to create a suitable portfolio. According to Rabin (2000), Rabin and Thaler (2001) it is necessary to give great emphasis on investor worries about underperformance it means to minimize losses under expected returns. Therefore in this article is suggested method for analyzing equity markets indexes mostly with the focus on loss aversion of private investors.

1. Subjective expected utility theory and loss aversion

The theory of individual investment decisions often assumes that financial risk is measured by the variability of yields, so that well-informed individuals can trade off this risk with the return in deciding whether to purchase the investment product. Such a risk-return trade-off is usually modelled using the well-known subjective expected utility theory (SEUT) framework, where the individual's reluctance to hold risky assets is driven by their degree of risk aversion (Eeckhoudt & Gollier, 1995).

Capon et al (1996) found that return and risk comprise only part of the decision process for individuals and that attributes other than return and risk are actively considered and weighed by investors in unit trusts: these individuals responded to perceived risk, rather than objective risk. Worzala et al (2000), and Diacon and Ennew (2001) also suggest that the principles of perceived risk may be helpful in understanding investor behaviour.

Other researchers have noted that an individual's distaste for losses is more broadly based than mere dislike of volatility; instead risk-taking behaviour is characterised by an aversion to losses (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992).

Kahneman and Tversky (1979) propose theory

called Prospect Theory (PT) as a descriptive model of decision making under uncertainty. The prospect theory is not a normative theory, but a descriptive approach to explain real world behaviour. Kahneman and Tversky realised a series of experiments to identify the manner in which people make choice in the face of risk.

The theory describes such decision processes as consisting of two stages, editing and evaluation. In the first, possible outcomes of the decision are ordered following some heuristic. In particular, people decide which outcomes they see as basically identical and they set a reference point and consider lower outcomes as losses and larger as gains. In the following evaluation phase, people behave as if they would compute a value (utility), based on the potential outcomes and their respective probabilities, and then choose the alternative having a higher utility.

The formula that Kahneman and Tversky assume for the evaluation phase is (in its simplest form) given by

$$U = \sum_{i=1}^n w(p_i)v(x_i) = \\ = w(p_1)v(x_1) + w(p_2)v(x_2) + \dots + w(p_n)v(x_n).$$

Where x_1, x_2 are the potential outcomes and p_1, p_2 their respective probabilities. v is a so-called value function that assigns a value to an outcome. The value function (see the Figure 1) which passes through the reference point is s-shaped and, as its asymmetry implies, given the same variation in absolute value, there is a bigger impact of losses than of gains (loss aversion). In contrast to Expected Utility Theory, it measures losses and gains, but not absolute wealth. The function w is called a probability weighting function and expresses that people tend to overreact to small probability events, but underreact to medium and large probabilities.

The value function shows the sharp asymmetry between the values that people put on gains and losses.

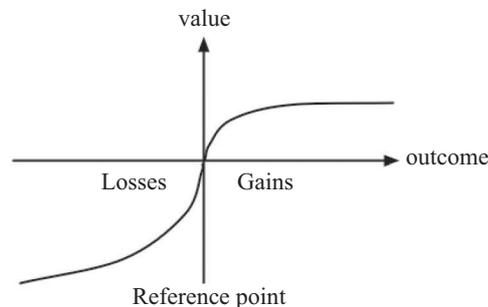


Figure 1. The value function.

ses. This asymmetry is called loss aversion. Empirical tests indicate that losses are weighted 2–2,5 times as heavily as gains (Kahneman and Tversky, 1991).

Like its mean-variance theor counterpart from the traditional approach, prospect theory focuses on the way people choosing among alternatives. But the theories are different. People who conform to prospect theory tend to violate the principles that underlie mean-variance theory.

According findings above loss aversion preferences imply that private investors who dislike losses will demand greater compensation, in the form of higher expected returns, for holding shares with high downside risk.

2. Risk measurements

During historic period, problems of objectifications of risk measurement by using a concept of probability and applying statistical analysis were discussed. In 1952, two authors published ultimate papers for financial industry, the first was H. Markowitz (1952) who identified risk as related to the varying financial outcomes and adopted the standard deviation of the residual assets as the tool for measurement of risk. He also provided a quantitative framework for measuring the portfolio risk. The second one was A. Roy (1952) who introduced the “Safety First” criterion, which meant introduction of a downside risk measurement principle. A few years later, Markowitz (1959) gave a generalized discussion on risk, and introduced alternative measurements tools as semivariance, expected value of loss, expected absolute deviation, probability of loss and the maximum loss. Markowitz introduced also his idea of downside-risk and suggested two types for measurement of a downside risk:

- a semivariance computed from the mean return or below-mean semivariance (SV_m)
- a semivariance computed from a target return or below-target semivariance (SV_t).

Both measures compute a variance using only the returns below the mean return (SV_m) or below a target return (SV_t). Markowitz called these measures partial or semi-variances, because only a subset of the return distribution is used (Nawrocki, 1999):

$$SV_m = \frac{1}{K} \sum_{T=1}^K \max[0, (E - R_T)]^2,$$

$$SV_t = \frac{1}{K} \sum_{T=1}^K \max[0, (t - R_T)]^2,$$

where R_T is an asset return during time period T , K is the number of observations, t is the target rate of return and E is an expected mean return of the asset's return. A maximizing function denoted as max, indicates that the formula will square the larger of two values i.e. 0 and $(E - R_T)$ or $(t - R_T)$. After proposing the semivariance measure, the classical author stayed with the variance measure because it was computationally simpler. The semivariance optimization models using a cosemivariance matrix (or semicovariance if that is your preference) require twice the number of data inputs than the variance model. With the lack of cost-effective computer power and the fact that the variance model was already mathematically very complex in these times as it belonged to the class of quadratic programs, this was a dominant consideration in practical applications until the 1980s with the advent of the microcomputer (Nawrocki, 1999). Markowitz (1991) also further developed this approach, in order to define a measure of downside risk.

According findings by Kahneman and Tversky's (1979) loss aversion preferences imply that investors who dislike downside losses will demand greater compensation, in the form of higher expected returns, for holding shares with high downside risk.

Sortino and Van der Meer (1991) note that standard deviation has one major drawback. Standard deviations measure uncertainty or variability of returns but in some cases this does not match one's intuition about risk. Large positive outcomes are treated as equally risky as large negative ones. In practice, however, positive outliers should be regarded as a bonus and not as a risk. It is therefore better to look at some measure of downside risk.

3. Applied Methods and Data

For application of loss aversion attitude of private investor there were been taken a set of stock indexes. An each investment index has undergone a deep risk measurement and risk analyses to compare each to another. The aim was to choose these investment indexes with lowest below-target semivariance, where target is set to 0 and make a “loss aversion-return” optimization of these investment indexes which covered an inflation rate of assets. There were chosen these investment indexes:

- MSCI World Net Return Index is the composite equity index covering countries in the developed markets. The index is capitalizations weighted.
- MSCI High Dividend Yield Index Net Return is the composite equity index covering countries in

the developed markets. The index is capitalizations weighted. Securities entering the index must have a dividend yield which is at least 30% higher than the MSCI World Net Return Index yield.

- STOXX Global Select Dividend 100 Net Return is the composite equity index covering countries in the developed markets. Companies are selected on the basis of dividend criteria and the weighting of the companies in the index is purely based on dividends.
- CECE Net Return Index is the composite equity index comprising the Czech Republic, Hungary, and Poland. It is a capitalization-weighted index consisting of the Czech, Hungarian, and Polish blue chip stocks, which are members of the respective country index: CTX Czech Traded Index, HTX Hungarian Traded Index, and PTX Polish Traded Index. The index is calculated and disseminated by Wiener Börse.
- CECE SD Net Return index is the composite equity index covering 10 highest dividend paying stocks from CECE NR Index. The index is an equally weighted.

Natural Monopoly Index 30 Infrastructure Global Net Return is the composite equity index covering liquid and tradable exposure to 30 companies around the world which provide basic infrastructure facilities. These companies are natural monopolies.

There were obtained 54 quarterly data per each index (period 1q1999–2q2012). It is a relatively small sample to make some strong conclusions, due to this fact, some parametrical tests were not found suitable. Therefore, there were used some robust statistical methods. It means that statistical methods aim at constructing statistical procedures that are stable (robust) even when the underlying model is not perfectly satisfied by the available dataset. A typical example for the assumed model is the presence of outliers – observations that are very different from the rest of the data. Outliers are “bad” data in the sense that they deviate from the pattern set by the majority of data (Huber 1981, Hampel et al. 1986). Hence, they tend to obscure its generic flow and may lack explanatory and predictive power regarding the generic portion of the data. Robust models focus on the statistical properties of the bulk of the data without being distracted by outliers, while in classical models all data equally participate in the analysis. Classical estimators that assign equal importance to all available data are highly sensitive to outliers. Therefore, in the presence of just a few extreme losses, classical analysis can produce arbitrarily large estimates of mean, variance, and other statistics. Bassett

et al. (2004) investigate the performance of portfolio return distribution using robust and quantile-based methods, and conclude that the resulting forecasts outperform those under a conventional classical analysis. Perret-Gentil and Victoria-Feser (2005) used robust estimates for mean and the covariance matrix in the mean-variance portfolio selection problem. They showed that the robust portfolio outperforms the classical one, as the outlying observations (that account for 12.5% of the dataset) can have serious influence on portfolio selection under the classical approach. This trimmed method is applied because some indexes lead to skewed distributions and there are extreme values. The same purposes, i.e. the presence of skewed distributions and extreme values, led to use the interquartile range (by practitioner’s hint for a normal distribution is approximately equal to $1,35 \cdot \text{standard deviation}$).

Another method which was used for estimating risk was computationally-intensive method due “eliminating” extreme values and the problem of short time series data. There were made 5000 bootstrap samples and computed main statistics.

3.1 Realization

An explanatory data analysis of all indices were made firstly. Results are shown in Table 1.

Note: Distributional characteristics of the quarterly period are expressed in €

According to the descriptive data analysis one could say that medians are greater than means in all cases. Trimmed means (12.5%) are greater than medians and than means for CECE and NMX indexes. Below mean target semideviations are in all cases smaller than the related standard deviations because target was set to 0. In addition, kurtosis statistics show

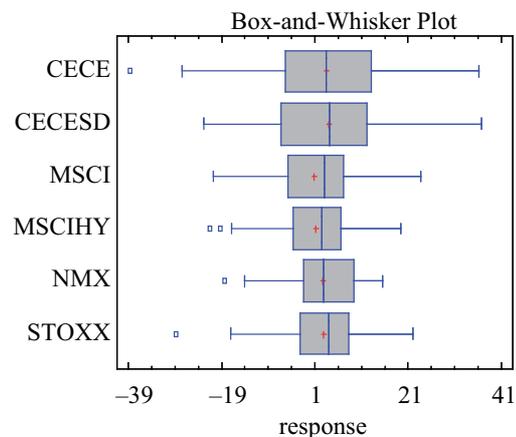


Figure 2 Box and Whiskers plot. Source: Author’s own.

Table 1 Quarterly summary statistics of equity indices

	MSCI	MSCI HY	STOXX	CECE	CECESD	NMX
Mean	0.87	1.27	2.87	3.39	3.91	2.61
Median	3.05	2.5	4	3.45	4.1	2.95
12.5% Trimmed mean	1.65	2.07	3.44	3.69	3.55	3.06
Standard Deviation	9.35	8.76	9.28	15.01	13.15	7.48
Below target semideviation (T=0)	6.66	6.18	5.81	9.18	6.76	4.36
Minimum	-20.7	-21.6	-28.7	-38.6	-22.9	-18.4
Maximum	23.7	19.4	22	36.2	36.7	15.6
Interquartile range	44.4	41.1	50.7	74.8	59.6	34
Std. Skewness	-1.54	-2.08	-2.33	-0.84	0.69	-1.61
Std. Kurtosis	0.49	0.68	2.68	0.43	-0.46	0.29

Source: Author's calculation.

Table 2 Result of the normality tests.

Test Shapiro-Wilk W	Statistic	P-Value
CECE	0.989164	0.966985
CECESD	0.98503	0.879944
MSCI	0.957521	0.102813
MSCIHY	0.952936	0.0626981
NMX	0.967152	0.268058
STOXX	0.963872	0.196406

Source: Author's calculation.

that the distributions have fatter tails than normally distributed variables. Next the related Box and Whiskers plots were made and results are shown in Figure 2.

According to these partial findings, the Shapiro-Wilk test of normality of distributions has been made. This test is based upon comparison of the quantiles of the fitted normal distribution to the quantiles of the data. Results are shown in Table 2. The results for all indices were the same and we can not reject the idea that these indexes come from a normal distribution with at the 5% significance level.

Table 3 Annualized summary statistics of equity indices in € (period 1q1999–2q2012).

	Mean*	Standard deviation**	Sharpe ratio***
MSCI	3.48	18.7	0.11
MSCI HY	5.08	17.52	0.15
STOXX	11.48	18.56	0.48
CECE	13.56	30.02	0.36
CECESD	15.56	26.3	0.49
NMX	10.44	14.96	0.53

* annual returns are calculated as quarterly values multiplied 4.

** annual standard deviations are calculated as quarterly values multiplied 2.

*** risk free value is set to 2.5%.

Source: Author's calculation.

Table 4 A bootstrap annualised characteristics.

	MSCI	MSCI HY	STOXX	CECE	CECESD	NMX
Mean	3.1	4.8	10.8	13.8	16.3	10.3
Median	3.8	5.7	11.9	14.6	16.1	10.9
Standard deviation	18.3	17.1	18.1	29.3	25.8	14.6
Below target semideviation (T=0)	11.2	9.6	7.4	13.2	9.1	5.2
Sharpe*	0.03	0.13	0.46	0.39	0.53	0.53
Sortino Ratio	0.28	0.5	1.46	1.05	1.79	1.98

* risk free value is set to 2.5%.

Source: Author's calculation.

Within finance, investment risk is commonly defined by standard deviation, which has one major drawback. Standard deviations measure uncertainty or variability of returns but in some cases this does not match one's intuition about risk. Large positive outcomes are treated as equally risky as large negative ones. In practice, however, positive outliers should be regarded as a bonus and not as a risk. It is therefore better to look at some measure of downside risk. Next was Sharpe ratio calculated for each index see Table 3.

A bootstrap technique was applied for risk measurement and other indicators next. There were made 5000 bootstrap samples of set of four quarterly data (Table 4).

4. Discussion

According obtaining result in the process of data analyzing of indexes there were find these facts:

- Capitalizations weighted indexes are worse in both: return and risk than dividend indexes (MSCI World Net Return Index vs. MSCI High Dividend Yield Index, CECE Index vs. CECE SD Index).
- According Sharpe ratio (for the define risk free value) and according Sortino ration is the best equity index Natural Monopoly Index 30 Infrastructure Global.
- The second best index was CECE SD index. This fact is very useful for creating investments portfolios mainly for private investors from Visegrad's countries.
- Two indexes are largely negatively skewed (MSCI High Dividend Yield Index, STOXX Global Select Dividend) but their standards deviations and below target semiviation are smaller than their counterparts. The explanation is one or two very negative returns due the observed period comparing to the others.
- Sortino ratio is a better criterium than Sharpe ratio because there is no "penalization" when the index values fluctuations are in the value of upwards to target or mean value.

Conclusion

A risk-return trade-off is usually modelled using the well-known subjective expected utility theory (SEUT) framework, where the individual's reluctance to hold risky assets is driven by their degree of

risk aversion. There is now general agreement that the theory does not provide an adequate description of individual choice: a substantial body of evidence shows that decision makers systematically violate its basic tenets. Many models have been proposed in response to this empirical challenges.

Kahneman and Tversky propose theory called Prospect Theory as a descriptive model of decision making under uncertainty. The prospect theory is not a normative theory, but a descriptive approach to explain real man behaviour. They define the value function which shows the sharp asymmetry between the values that people put on gains and losses. This asymmetry is called loss aversion. Empirical tests indicates that losses are weighted 2–2.5 times as heavily as gains.

This approach can be applied to private investors who are averse to risk. These investors are worried about any loss of value of their wealth. If these investors choose to invest in stocks they should prefer to invest in the stock indices with down side risk close to zero, respectively those whose down-side risk is lowest. These investors are not interested primarily about profitability, but with the possibility of preservation of their assets.

There were explored the selected risk characteristics of important stock indexes using standard statistical techniques, robust statistical techniques and computer simulated technique.

The results show differences among equity indexes, mainly between capitalizations weighted indexes and dividend indexes.

Using downside risk measurement is revealing as it lays bare the "true" risk of investing in stock markets mainly for risk averse private investors. A bootstrap method with down side risk metric can evaluate risk in more appropriate way, and it is also more suitable if statistical characteristics do not fulfil a normal distribution assumption (mostly because of fat tails or outliers).

And lastly the question if a private investor should invest into equity indexes is not to answer without optimalization of all asset classes in which a private investor wants to invest. It depends mainly on expected target return and his/her risk capacity connected with time horizon. Neither a loss averse investors should some part of his/her wealth invest into equity indexes (may be 15% max.25%). As the best equity index for a loss averse investor was chosen Natural Monopoly Index 30 Infrastructure Global with the smallest down side risk.

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