Management Performance Measures Based on Portfolio Returns' Standard Deviation – Are They Applicable in a Low Liquidity Market Environment?

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Summary: Limited liquidity is one of the major differences between small and low-liquid emerging capital markets, such as the Bulgarian one, and the developed ones, on which the financial theory is based. Low liquidity causes significant market distortions and this hinders the application of financial theories on such markets directly. The aim of this article is to analyze the distorting effect of low liquidity on the management performance measures based on overall risk, measured by the standard or semi-standard deviation of portfolio returns – Sharpe Measure, Sortino Ratio, etc. Basing our conclusions on empirical tests we argue that during a phase of both rising market or a market correction, the lower the liquidity of stocks is, the higher their standard deviation and this relation most probably strengthens during a time of decreasing markets. During a period of rising markets however, as the probability distribution of stocks returns with lower-liquid stocks tends to be positively skewed, the higher standard deviation of returns shows profit potential rather than risk. During market correction, the skewness of the distribution of these stocks' returns tends to "shrink" closer to zero and the standard deviation of returns further increases. Thus, standard deviation becomes a more adequate measure of risk and this risk has increased. This risk, however, remains "hidden" for the classical management performance measures while the market is rising and becomes visible only after correction has started and the investors have suffered losses. Empirically we prove that the low liquidity of the market is among the major reasons for the limited information power of management performance measures.

Key words: Management performance (measurement), return, risk, overall risk, Sharp Measure, Sortino Ratio, probability distribution of returns, standard deviation, semi-standard deviation, skewness, liquidity, VaR-analysis.

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Introduction

During the last few years, especially since Bulgaria became an EU member, Bulgarian Stock Exchange (BSE) has attracted significant resources both from individual and from local and international

institutional investors. The record rates of return observed in 2007 enhanced the role of investment in shares as an alternative to the traditional forms of saving for Bulgarian citizens, including the indirect forms of such investment through undertakings for collective investment (UCI). With the development of the world financial crisis, however, the record profits faded away soon and a large part of the investors endured record losses.

These extremes, witnessed by us, raise the sensitive question of risks related to the composition of share portfolios traded on low liquidity markets like the Bulgarian market.

Maybe the most important measures concerning investment portfolios are those establishing a correlation between the portfolio rate of return and its risk, evaluating at the same time the efficiency of a given (active) investment strategy in comparison with a passive one, the latter being normally easier to define and maintain, involving lower costs. These are the management performance measures. Part of them are based on standard deviation or semi-deviation as a measure of risk (Sharpe measure, Sortino ratio, etc.), while others are based on systemic risk, calculated using the Capital assets pricing model (CAPM) – Treynor measure, Jensen measure.

On low liquidity markets like the Bulgarian market, however, the low liquidity causes distortions in the classical management performance measures, becoming the reason for incorrect assessment of portfolio efficiency and for the impossibility of evaluating well enough the exact scope of risks that are undertaken.

The present study proves empirically that the management performance measures based on standard deviation or semi-deviation are indeed "overstated" in the conditions of growing market because of the high standard deviation of the rate of return, accompanied by a positive coefficient of asymmetry of return distribution. This is due significantly to lower liquidity. On the other hand, the systemic risk on low liquidity markets cannot be always correctly evaluated, which could make the application of management performance measures based upon CAPM meaningless. This is again due to a high degree to the low liquidity of these markets, which is proven empirically.

The increased importance of investment in shares compared to other traditional forms of savings management for different investors, the higher role of mutual funds and open-ended investment companies in the Bulgarian financial system, and their growing popularity among investors despite the current severe state of the world financial crisis result in increased importance of measuring the efficiency of share portfolio management. This is the purpose of calculating management performance measures. In general terms, these measures compare the rate of return of the portfolio to its level of risk, a ratio representing indeed the portfolio efficiency. The indicators compare the portfolio rate of return for a certain period of time with the additional risk that is undertaken to a certain standard model – usually a passively managed portfolio of approximately the same class of risk. This is important, because in addition of evaluating the risk/return ratio of the portfolio itself, the purpose of these measures is to show whether the same result could be achieved by applying a passive strategy, which is usually simpler to draw up and follow and is associated with lower implementation costs.

The management performance measures accepted in international theory and practice are calculated using exclusively statistical indicators, obtained empirically by analysis of historical market data – standard deviation, beta- and alfa- coefficients. The studies are based upon assumptions that are more or less valid for the developed capital markets. The question arises,

however, as to what extent these measures are applicable to share portfolios traded on the Bulgarian stock market, the latter being quite different from the markets, for which the standard management performance measures are developed. Even in their application to developed markets, where accessible information is available for longer time periods, the practical applicability of these measures is often limited.

The Bulgarian capital market is characterized by lower liquidity and this is a source of major problems in the application of management performance measures to portfolios consisting mainly of assets from low liquidity markets. These measures do not account for the liquidity effects, either on changes in the rate of return on assets, therefore on the portfolio, or on the risk, measured by standard deviation, variance, or the beta-coefficient.

The purpose of the present paper is to clarify how and to what extent low liquidity decreases the information value of some of the most popular management performance measures applied in Bulgaria – Sharpe measure and Sortino ratio. These are measures based on standard deviation (semi-deviation, respectively) of the portfolio rate of return as a risk measure. We present an empirical study showing the influence of low liquidity on standard deviation of the rate of return on shares and share portfolios and, in particular, of the mutual fund share portfolios.

The results from the empirical studies demonstrate that the low liquidity of shares traded on Bulgarian Stock Exchange results in "overstating" of Sharpe measure and Sortino ratio during a growing market period, while the risk of suffering high losses during a market correction period stays hidden for analyzers and investors. This is due to the fact that standard deviation of the rate of return on low liquidity shares is not a reliable measure of risk because of its variable asymmetry during transition from a growing market period to a market correction period.

1. Sharpe measure and Sortino ratio

Sharpe measure

Under this approach, the mean of return in excess of the risk free rate for a certain period of time is related to the overall risk of the portfolio, measured by standard deviation of its rate of return for the same time interval, or:

$$S = (r_p - r_f) / \sigma_p ,$$

where:
S – Sharpe measure;
r_p – Mean of Return;
r_f – Risk Free Rate;
σ_p – Standard deviation of the portfolio rate of return.

When the portfolio, respectively the fund, is new or has very short history, as well as when an assessment of the changes in its structure is needed, the portfolio standard deviation can be obtained on the basis of standard deviations of the comprised assets and the correlations between them, using Markowitz formula.

The measure was introduced by William F. Sharpe in his study "Mutual Fund Performance", published by the Journal of Business in 1966[1].

[1] The Journal of Business, Vol. 39, No. 1, Part 2: Supplement of Security prices (Jan., 1966), pp. 119-138.

Sortino ratio

In 1994, **Sortino and Price**[2] demonstrated that if there is a minimal return, necessary for attaining a given target, i.e. a "minimal acceptable return" (MAR), then any case of realized return above MAR will represent a favorable outcome and, respectively, any case of realized return below MAR will represent an unfavorable outcome. As risk is associated with unfavorable outcome, only returns below MAR are related to risk. The **Sortino Ratio** was developed as a result of this argument,

The Sortino Ratio compares the rate of return in excess of the target rate of return with the downside standard deviation (unfavorable variability).

$$\text{Sortino Ratio} = \frac{\bar{\alpha}}{DD}$$

DD – downside standard deviation (unfavorable variability).

2. The "liquidity" problem on the Bulgarian market and how it affects the applicability of most popular management performance measures

The main difference between our market together with many other emerging markets and the developed financial markets, is probably the strongly limited liquidity in all its aspects. On one hand, there are only few large companies (before the lowest point of the crisis, there were only four companies with capitalization of about one milliard leva), and even they have very low average daily traded volumes. As a whole, companies offering to the investor stable financial status and development prospects in combination with satisfactory liquidity level (especially with respect to institutional investor requirements) are no more than fifty-sixty, while the total number of registered clients on the stock market is over three hundred. Thus, on one hand, the so called scarcity value is generated for higher liquidity shares, resulting in certain overpricing. On the other hand, during a correction period, when mutual funds are forced to deal with significant withdrawal of resources from the part of their investors, higher liquidity assets are those subject to massive sales. It is quite logical for mutual funds to invest a higher portion of their assets in such shares especially because of liquidity considerations. A similar problem arises for the other groups of institutional investors as well, although at a different rate because of the differences in their operations and, therefore, in liquidity management.

The other side of the coin is the lower liquidity shares. Their price can change brusquely and to a high degree at very low traded volume, either as a consequence of the normal play of market forces, or because of deliberate market manipulations. In this way, their low liquidity usually contributes to the sharp rise of their prices in a growing market. When the market is declining, they usually are not sold out significantly by the mutual funds to ensure the needed liquidity, as their limited liquidity would result in serious losses. Because of the limited volumes of demand for such shares (during a downside market trend, in particular), possible higher sold amounts of these shares would take place at a very low average weighted price. For this reason, in the last BSE correction we saw sharp decrease in prices exactly of higher liquidity positions. However, in case mutual funds are in higher need of liquidity and they are forced to sell out shares from their lower

[2] Sortino, F. A. & L.N. Price, 1994, "Performance measurement in a downside risk framework", Journal of Investing, Vol. 3, pp. 50-8.

liquidity positions and/or if some other market factors cause the sale of such positions by third parties, the investor losses would be large (these are high volatility shares and, as we pointed out, with very limited financial resource or transaction volume, so the price of these shares may fall drastically). However, such shares occupy a higher portion of investors' portfolio compared to SOFIX, for example, which is considered a model portfolio. This means that during a growing market period, maintaining a higher portion of such shares in the portfolio can improve significantly the management performance measures, in case these measures do not account for low liquidity. The portion of such shares can grow relatively, of course, within the liquidity management requirements and the limits on investment established, for example, by institutional investors – internal and external. Then, the measures will not account for the hidden risk of a market trend turn-around, precisely when low liquidity shares can result in significant losses for the portfolio.

This is one of the main weaknesses of the classical management performance measures – they do not account for the potential risk of extreme losses due to low liquidity. This risk is not realized, or is realized to a lower degree, during growing market periods and the measures calculated on the basis of data from a period of upside change in share prices would not take into account this risk. It will be taken into account to a certain degree only if the period of study covers both a growing market period and a correction period. This may present a problem on emerging markets, which are mostly growing. In this case, even when the study period is long enough and covers market movements in both directions, if the used data is with lower frequency – monthly, quarterly, etc., the growing market trend will again "conceal" to some extent the lower liquidity effect. This happens because within the longer time period (three months, six months, or one year), the shares would have demonstrated a positive rate of return despite the occurrence of correction during a certain subperiod of the longer study period. However, this subperiod may be of considerable length itself – several months, for example (as it is the case with BSE at the moment), during which investors may suffer considerable losses. This possibility stays hidden for the classic management performance measures.

In order to prove empirically the conclusions made above, we present the results of a study on eighty of the most traded shares on BSE both during growing and declining market periods, including shares of investment companies (closed-end). The study period covers 01.01.2007 – 18.02.2008, with market movement in both directions. The analysis was made using daily and weekly data.

3. Problems with applying Sharpe measure and measures based on asymmetry of probability distribution of returns (Sortino ratio) resulting from limited liquidity of the market

One of the main problems in applying Sharpe measure, as well as other management performance measures, based on standard deviation of the rate of return as a risk indicator, with respect to portfolios based on small and low liquidity markets, is the fact that very often, in the case of low liquidity shares, standard deviation is not reliable enough in measuring risk. In addition, the parameters of probability distribution of returns of low liquidity shares are such that they can create misleading expectations for potential loss, in case the market moves from a growing phase into a correction phase. This leads to problems in evaluating management performance on portfolios, containing significant volume of lower liquidity shares.

3.1. Empirical approach

We present below the results from our analysis of the way parameters of probability distribution of returns for eighty shares, traded on BSE floor, change during transition from a growing market phase to stock market correction phase and how these parameters are related to share liquidity. The monitored parameters are standard deviation, mean of return, and asymmetry coefficient (a positive/negative asymmetry coefficient shows to what extent the probability of realizing returns above average is higher/ lower than the probability of realizing returns below average). The average daily turnover of shares in leva for the last two hundred and forty days is used as a variable reflecting the degree of liquidity.

Initially, we used regression analysis, in which the parameters of distribution of returns represent sequentially the dependent variable and the selected liquidity measure is the independent variable. We carried out the analysis of the upward market trend, then of the correction period.

The purpose is to find out if there is a significant relationship between share liquidity and the parameters of distribution of their rate of return and if this relationship changes during the transition from a growing market phase to a correction phase. For this purpose, in addition to regression analysis, we also use cluster analysis, arriving at the same results. Cluster analysis provides a somewhat better visual illustration of the results by groups of shares ranked by liquidity and the parameters of the probability distribution of their returns.

In addition, we check how the distribution parameters change with the change in the market trend and what kind of change happens in the different groups of shares ranked by liquidity.

Eighty shares from those most traded on the stock exchange, including shares of investment companies, are explored both during a market growth period and a correction period. The group contains shares included in SOFIX, BG40, as well as other shares traded during the two subperiods and being a part of at least 70 % of the trading sessions during the respective period. Fibank, the Corporate Commercial Bank, Devin, Lomsko pivo, and Kaolin are also included, although their shares have been traded for shorter time due to the recent initial public offerings. Nevertheless, they are included because of higher liquidity and of the fact that they occupy an important portion in the portfolios of institutional investors. Himimport was not included in the analysis, as its shares are with much better liquidity than other shares (considerably higher average daily volume), which would bring distortions into the analysis. Special investment vehicles were also excluded from the group, as because of their economic characteristics, they have lower volatility and move in a weaker correlation with the market. Therefore, as our purpose is to measure the liquidity effect without being influenced by sector characteristics of the share or other external factors, we had to exclude these shares from the analysis.

The study carried out in this way contributes to a better judgment of the effect, which the increase of lower liquidity shares in the portfolio would have on the parameters of the risk/return ratio of this portfolio.

3.2. Results from the regression analysis and their interpretation

Below are the results from the regression analysis during the market growth phase – 01.01.2007 – 23.01.2007 and 09.05.2007-05.10.2007 (daily data). The two subperiods are determined on the basis of SOFIX local tops and bottoms.

Table 1.

Standard deviation									
R = .38041098 R2 = .14471252 Corrected R2 = .13299625 F = 12.351 p < .00076 Statistical error: 1.9582									
	Standard	St. error	Regr.	St. error -	t	p-level	Correl. coef.		
	regr. coef.	st. regr. coef.	coef.	regr. coef				Av. turnover	St. deviation
Intercept			4.304383	0.277415	15.51608	0.000000	Av. turnover	1.000000	-0.380411
Average daily turnover	-0.380411	0.108242	-0.000005	0.000001	-3.51443	0.000761	St. dev.	-0.380411	1.00000C

The results reveal the relationship between standard deviation of the rate of return and the liquidity of shares. A statistically significant correlation coefficient of -0.38 can be observed. This indicates the existence of a medium statistically significant inverse relationship between share liquidity and volatility, i.e. shares with lower liquidity are more volatile and vice versa. In addition, liquidity helps explaining 14 % (0.144 determination coefficient) of the differences in volatility of shares during a growing market. It can be seen that the regression model is not sufficiently precise to forecast share volatility. This is quite normal, however. Multiple factors influence share volatility and liquidity of shares is simply one of those factors, explaining no more than 14 % of volatility. But the purpose of the present model is just to establish the existence of a relationship between liquidity and standard deviation, and to give an idea about the degree and strength of this relationship.

For the growing market phase, regression analysis (using the available database) of other distribution parameters does not show any statistical significance.

Table 2.

Intercept	Intercept
AVETURN	Average daily turnover
STDEV	Standard deviation of the daily rate of return
SKEW	Asymmetry coefficient of the distribution of the daily rate of return
R2	Determinance coefficient

	Dependent variable: STDEV R = .52750818 R2 = .27826488 Corrected R2 = .26851170 F = 28.531 p < .00000 Statistical error: 2.4037					
	St. regr. coef.	Statistical error of st. regr. coef.	Regr. coefficient	Statistical error of regr. coef	t	p-level
Intercept			7.346679	0.334683	21.95117	0.000000
AVETURN	-0.527508	0.098758	-0.000009	0.000002	-5.34141	0.000001

Here are the results of the regression analysis of the relationship between the parameters of probability distribution of share returns and their liquidity during the downside market period, 01.01.2007-08.05.2007 and 08.10.2007-24 .02.2009. The table below and the graphics underneath show the results from the regression analysis of standard deviation.

It can be seen that there is a statistically significant coefficient of -0.52. This means that during a downside market period, there is also a medium and statistically significant inverse relationship between liquidity and volatility of shares. Moreover, 28 % of the differences between share volatility during downside market can be explained by liquidity (determinance coefficient 0.28), which allows us to assume that the relationship is probably a bit stronger for a downside market period than for an upside market period. It can be seen that the regression model is not sufficiently precise to forecast share volatility, but it shows a significant relationship between variables.

Unlike the observed lack of statistical significance in the relationship between the asymmetry coefficient of the shares' rate of return and their liquidity during a growing market period, such a relationship is present during a downside market period.

A statistically significant correlation coefficient of -0.48 can be observed. The meaning is that during a transition to downside market, a medium to weak statistically significant inverse relationship still exists between liquidity and the asymmetry coefficient of the shares' rate of return. Moreover, 23 % of the differences in the asymmetry coefficient of shares during downside market can be explained through liquidity (determinance coefficient 0.23). It can be seen that the regression model is not sufficiently precise to forecast share volatility, but it shows a significant relationship between variables.

These results show that during a downside market period higher liquidity shares have a lower asymmetry coefficient (determined by its sign). However, this result is misleading to some extent with respect to the purpose of our analysis. As we will see below in the interpretation of the results from cluster analysis, this result from the regression analysis of asymmetry under downside market is due to the fact that during market correction, mainly high liquidity shares were sold in order to ensure liquid funds. Besides, large foreign institutional investors on BSE hold Bulgarian shares with higher liquidity. With the onset of turbulences on international capital markets, foreign investors were among the first who started withdrawing resources from investments on BSE (the first case with a stronger effect on the market was the withdrawal of about fifty million leva from Bulgarian mutual funds by the pension company of Alianz Bulgaria). This is how we can explain the fact that shares with considerably higher

Table 3.

	Dependent variable: SKEW R = .48071461 R2 = .23108653 Corrected R2 = .22069581 F = 22.240 p < .00001 Statistical error: .69484					
	St. regr. coef.	Statistical error of st. regr. coef.	Regr. coefficient	Statistical error of regr. coef	t	p-level
Intercept			0.563063	0.096747	5.81994	0.000000
AVETURN	-0.480715	0.101935	-0.000002	0.000000	-4.71590	0.000011

liquidity have, on average, a negative asymmetry coefficient during a correction period, while for lower liquidity shares this coefficient is most often positive, close to zero for the same period. This also explains the results from the regression analysis, because in this case the asymmetry coefficients are considered as numbers and their magnitude is determined by their sign.

If we repeat the analysis, dividing the database for the correction period into two groups of shares – the first with a positive asymmetry coefficient, and the second – with a negative coefficient, and if we repeat the regression analysis for each group separately in such a way as to compare the absolute values of the asymmetry coefficients, we obtain statistically insignificant results. However, this is probably due to the very low number of observations in both subgroups – 21 shares with a positive and 59 shares with a negative asymmetry coefficient.

As a summary of the results from the regression analysis, we can say that a medium inverse relationship is present between the liquidity of shares and their volatility – lower liquidity shares are, other conditions being equal, more volatile, and during a downside market period this relationship probably becomes stronger. During a growing market period, about 14 % of the difference in their volatility can be explained by the difference in the liquidity of shares, while during a downside market period this percentage is 28 %. In addition, the hypothesis that mostly higher liquidity shares were sold on the stock exchange was confirmed.

3.3. Results from the cluster analysis and their interpretation

Cluster analysis provides us with somewhat better information. The analysis was carried out using the same set of shares, one time with daily, and the second time with weekly data (daily data on share prices movement for 5 days). The number of clusters – 5 – was set in advance in

Table 4. Growing market, 01.01.2007 -23.01.2007 and 09.05.2007-05.10.2007

Clusters	C1	C2	C3	СД	C5
Number of shares	3	5	8	14	42
Standard deviation	1.494	2.853	3.260	2.889	4.517
Asymmetry	0.449	1.054	0.870	1.154	1.200
Average rate of return	0.282	0.937	0.839	0.816	0.816
Average daily turnover	691.265	403.089	239.041	104.753	18.979
Loss, probability in %(using the normal distribution parameters)					
25	-0.72	-0.97	-1.35	-1.12	-2.21
10	-1.63	-2.72	-3.33	-2.88	-4.97
5	-2.18	-3.77	-4.54	-3 95	-6.64
1	-3.20	-5.71	-6.76	-5.91	-9.71
Profit, probability in %(using the normal distribution parameters)					
25	1.28	2.85	2.75	2.75	3.84
10	2.20	4.59	4.51	4.51	6.60
5	2.75	5.64	5.58	5.53	0.27
1	3.76	7.58	7.55	7.55	11.34

Table 5. Downside market, 24.01.2007-08.05.2007 and 08.10.2007-24.02.2009

Clusters	C1	C2	C3	C4	C5
Number of shares	3	6	12	15	34
Standard deviation	3.360	3.680	4.270	5.430	8.050
Asymmetry	-0.930	-0.480	0.240	0.320	0.57C
Average rate of return	-0.390	-0.530	-0.350	-0.430	-0.240
Average daily turnover	691,265	334.752	179,779	69.791	12.881
Loss, probability in %(using the normal distribution parameters)					
25	-2.64	-3.00	-3.21	-4.07	-5.63
10	-4.69	-5.24	-5.82	-7.38	-10.54
5	-5.93	-6.60	-7.40	-9.39	-13.52
1	-8.22	-9.10	-10.30	-13.08	-19.00
Profit, probability in %(using the normal distribution parameters)					
25	1.86	1.94	2.51	3.21	5.15
10	3.91	4.18	5.12	6.52	10.06
5	5.15	5.54	6.70	8.53	13.04
1	7.44	8.04	9.60	12.22	18.52

the model. We consider again the relationships we are interested in for upside and downside market.

The results from the cluster analysis are presented below:

Clusterization was done on the basis of the parameters mean of return, asymmetry coefficient, standard deviation, and average daily turnover. It can be seen that the average daily turnover parameter has the highest weight in the distribution of shares into clusters both during the growing market period and during correction. The difference between the cluster mean and the value of the respective parameter for each share included in the respective cluster is the lowest precisely for the average daily turnover. Standard deviation is next according to this criteria. From the 4 listed parameters, these are the two showing the strongest mutual relationship and the share grouping is based upon them. This also confirms the results from the regression analysis on the most significant relationship between share liquidity and volatility.

We can notice that both during the growing market and the downside market phases, the last three clusters ranked by their liquidity manifest a considerably higher standard deviation of their rate of return. This is valid especially for the group of the lowest liquidity shares with average daily turnover of 18 979 leva. It can be also seen that the two clusters of lowest liquidity shares exhibit the highest positive asymmetry coefficient. A high positive asymmetry coefficient is also observed for cluster 2 (shares occupying the second place by liquidity). A major influence on this result also comes from non-liquidity factors – shares of Monbat, Kaolin, and Holding Roads are included here, among others. Their prices raised considerably during the growth period because of strong financial data, strong positive expectations for the construction sector, and the initial public offering of Kaolin, which took place during the abovementioned period. The initial public offerings (IPO) on BSE were

met with extreme interest at that time, because of the general euphoria, the scarcity value of IPO shares, etc. Similar factors, of course, are also present for the companies in the other clusters, but the cluster in question comprises 5 companies in total and, respectively, their shares have considerable weight. Another company in the cluster with substantial increase of its share prices is the Lead & Zinc Complex (during the correction period, respectively, many of its shares lost a large part of their value). The influence of non-liquidity factors and the relatively smaller number of observations are important factors for the low explanatory value of the regression models described above and for the fact that regression analysis does not show a significant relationship between the asymmetry coefficient and liquidity.

The higher positive asymmetry coefficient of lower liquidity shares shows that during a growing market period, the probability of realization of daily rates of return above average is quite higher for them than the probability of realization of daily rates of return below average. This, in combination with the considerably higher standard deviation and higher mean of return (see the tables above), determines a strong potential for increase of the value of these shares. This coincides with our expectations and is quite logical – because of the limited liquidity of the shares, which is associated with limited volume of demand and supply, single transactions of relatively low volume can move the price up considerably. **Correspondingly, during a growing market period, standard deviation of shares with more limited liquidity in practice does not demonstrate a risk of losses, but a potential for high gains and, indeed, the higher its value is, the more important this potential is, which is (seemingly) good for investors.**

What happens during a market correction period? First, it can be seen that standard deviation has increased for all share categories ranked by their liquidity. The average daily rate of return is negative for all categories, and the average loss is the highest for the second cluster of shares ranked by how actively they are traded, coinciding with cluster 2, observed during the growing market period – shares that were the fastest to raise, then also dropped sharply, because of collection of profits, of doubts for higher overstating – the reasons may be different. It can be also seen that the asymmetry coefficients have shrank for all share groups and are situated much closer to 0, the contraction being the strongest for the lower liquidity shares. The asymmetry coefficient of the highest liquidity shares has reached a negative value, showing higher probability of deviations below the average daily rate of return (loss in this case), due to larger sales of higher liquidity positions by mutual funds to cover the considerable resource withdrawal from the part of investors. We arrived at the same result using regression analysis, when we established a significant inverse relationship between liquidity and the asymmetry coefficient. A very important conclusion follows from the obtained results – **in a downside market period, because of the significant contraction of the asymmetry coefficient for all groups ranked by liquidity and, in particular, for the lower liquidity shares, standard deviation starts performing its risk measure function more correctly. The probability of deviation above and below the average rate of return (loss) is already equalized for the lower liquidity shares and their higher standard deviation is already associated with a real risk of higher losses.**

We will arrive at the same conclusion if we use cluster analysis of the changes in the three parameters of probability distribution of shares' daily rate of return during market transition from a growing phase to a correction phase. The differences between the value of

the respective parameter during a downside market period and its value during a growing market period were calculated for each single share. Then clusterization was done on the basis of the differences with respect to the three probability distribution parameters and the average daily turnover of shares. The results (the cluster numbers correspond to the tables above) can be seen below:

Share liquidity turned out to be again the strongest clusterization factor, compared to the other three. Passing of asymmetry due to non-liquidity factors (because of large selling out to raise liquid funds, as well as for other non-liquidity reasons, mentioned above) is also observed for shares with both highest and lowest liquidity. Standard deviation of lower liquidity shares increased considerably during the transition of the market from growth to decline, although it was the highest during the growing trend period.

3.4. Implications for management performance measuring

The conclusions reveal one of the main problems in the application of Sharpe measure to asset portfolios formed on small low liquidity markets. As during a growing market period the lower liquidity shares manifest stronger inclination towards registering a rate of return above average, their high standard deviation shows indeed a higher rate of return when the market trend is positive. Thus, the increase of the portion of such shares in the portfolio during a growing market period can result in a higher average rate of return of the portfolio than the one demonstrated by standard deviation, which automatically means an improvement of Sharpe measure –improvement on the account of decrease in liquidity. However, Sharpe measure does not register the risk of lower liquidity, which is considerable, as we demonstrated. Because, if during the next recorded period the market trend turns around, the high standard deviation will already show a real risk of losses above average (asymmetry coefficient close to 0). In case the fund (or the investor, in general) holds large enough positions of high liquidity shares to meet needs in ready money, arising during a correction stage, the losses would probably be not as high. This was observed for Bulgarian mutual funds during the correction period. In such a situation, it is possible that during the correction period as well, the fund would continue to demonstrate a better value of the management performance measures compared to the model portfolio. But if the fund is forced to sell lower liquidity shares because of demands for resource withdrawal that are higher than expected, for example, or if it simply has larger sales of low liquidity shares under the influence of other factors, the fund would suffer considerable losses. Such an effect can be the result even of single sales from the part of larger institutional investors.

Here we must boldly underline that even the highest liquidity positions on BSE have indeed an average daily turnover, which is small for

Table 6. Difference (downside market period, updated – growing market period)

	C1	C2	C3	C4	C5
Standard deviation	1.866	0.827	1.010	2.541	3.633
Asymmetry	-1.379	-1.534	-0.630	-0.834	-0.630
Average rate of return	-0.672	-1.467	-1.189	-1.246	-1.056

institutional investors and they are, in general, with limited liquidity. Therefore, with respect to the liquidity of shares traded at BSE, we can only speak of shares with relatively lower and higher liquidity, but not of high liquidity shares in principle. During the period of the last BSE correction, several of the highest liquidity shares on the stock exchange recorded sharp decrease of their value, which was due largely to the efforts of mutual funds to raise ready money. Even the high liquidity of these shares was not sufficient to hold to the pressure of sales. Moreover, this situation shows that the number of shares, which can be used as a reliable source of ready money under such market developments, is strongly limited. Therefore, portfolios consisting of shares, traded on BSE, face the "liquidity" problem even in case they comprise the highest liquidity shares on the stock market.

Moreover, by massive sales of higher liquidity shares, the fund would increase the standard deviation of its portfolio, which would result in further worsening of Sharpe measure. In short, **the problem of applying Sharpe measure in such cases is that it does not account for the lower liquidity risk, "hidden" during a positive market trend. And this is an important problem, especially on smaller low liquidity markets. The lower the amount of liquid shares making it possible to raise liquid funds without suffering too large losses is, the weaker the shares' liquidity is – from the point of view of supply volume in general and, in this specific case, mostly of demand volume, the lower the average daily trading turnover is, and the shallower the market is from the point of view of average price of the demand and supply amount for each single share at a certain moment in time, the higher the risk of suffering large losses from low liquidity positions will be. Respectively, the possibility of "overstating" Sharpe measure in a growing market will also be higher.**

4. Liquidity and extreme values of the probable profit or loss

There is another aspect to the problem of using standard deviation as a measure of the risk associated with shares and portfolios comprising them, especially with respect to shares with more limited liquidity. As a whole, most concepts regarding the calculation of risk and shares associated with it, both with respect to single shares and to portfolios, are based on the assumption of normal distribution of their rate of return. In principle, the probability distribution of returns on shares is often closer to Gamma-distribution – symmetrical, but with higher degree of "narrowness of the central peak" and heavy tailed, i.e. the probability of reaching extreme values of profit and loss is higher than for normal distribution. To the normality of distribution problem, we must also add the possibility of a high asymmetry coefficient – a problem, considered above.

On the basis of the obtained results, we may conclude that it is the low liquidity shares that will probably have heavier distribution "tails". Such a statement is logical, because, as we have already mentioned, in the case of lower liquidity shares, it is possible to considerably influence the price by single transactions of relatively low volume, so that it could rise or fall sharply. In other words, there is higher probability of extreme profits or losses. In this case, we again reach a situation, when standard deviation may not be a reliable measure of risk, even if the rate of return of the share or share portfolio is symmetrical with respect to the average rate of return. Let's consider two fully hypothetic shares (such a situation can also happen in reality), respectively two portfolios – A and B. In the tables below, the daily change of the value of the portfolio can be found in the "value" column, and the probability of realization of this rate of return is in column "probability, %".

It can be seen that portfolio B will have higher mean of return and lower standard deviation than portfolio A. However, the expected return/ risk ratio will be only slightly lower for portfolio B – Sharpe measure will be slightly weaker than for portfolio A. At the same time, however, it can be seen that portfolio B conceals a far greater risk of extreme losses, respectively a possibility of profits. This is an additional dimension of risk, not accounted for by standard deviation. To illustrate the problem more clearly, we arranged the distributions in such a way that their asymmetry coefficients are approximately the same. If the coefficient is higher for one portfolio in comparison with another one, then the problem of applicability of standard deviation as a risk measure becomes additionally complicated.

Table 7.

Portfolio A	
Value	Probability %
10.00	0.00
9.00	0.00
8.00	1.00
7.00	2.00
6.00	3.00
5.00	4.00
4.00	5.00
3.00	6.00
2.00	7.00
1.00	8.00
5.00	28.00
-1.00	8.00
-2.00	7.00
-3.00	5.00
-4.00	6.00
-5.00	4.00
-6.00	3.00
-7.00	2.00
-8.00	1.00
-9.00	0.00
-10.00	0.00

Mean	Standard deviation	Mean/St. deviation
1.39	4.01	0.35
Asymmetry		
-0.53		

Portfolio B	
Value	Probability %
10.00	2.00
9.00	1.00
8.00	0.00
7.00	0.00
6.00	0.00
5.00	2.00
4.00	4.00
3.00	5.00
2.00	8.00
1.00	15.00
5.00	26.00
-1.00	15.00
-2.00	8.00
-3.00	5.00
-4.00	4.00
-5.00	2.00
-6.00	0.00
-7.00	0.00
-8.00	0.00
-9.00	1.00
-10.00	2.00

Mean	Standard deviation	Mean/St. deviation
1.30	3.83	0.34
Asymmetry		
-0.48		

The probability of extreme losses for the portfolio with pre-selected probability (usually 5 %, 1 %) is evaluated through VaR-analysis (Value at risk). Therefore, it is good if the management performance measures account for the so called VaR portfolio assessment. – the percentage of extreme loss for a selected probability.

However, difficulties could be present in calculating VaR portfolio assessment. They may be linked again to low liquidity of shares – weak trade, lower number of observations, not sufficiently informative ratio between observations in which loss was reported and those with recorded profit (for example, when the market was growing within the considered period), etc.

There is also a low liquidity effect that VaR-analysis is unable to record. This is because many non-liquidity factors exert their influence on the VaR portfolio assessment. It is possible for two portfolios to have approximately equal VaR-assessments, but different liquidity. If there is a situation, when mutual funds are forced to sell out shares from their portfolios in order to meet demands for resource withdrawal by investors, losses will be present in selling higher liquidity shares, but they would be not as extreme as with lower liquidity shares, because of the relatively larger demand for the (relatively) higher liquidity positions. In this case, the recorded losses should be further away from the VaR portfolio assessment. However, if a fund's portfolio contains a larger portion of lower liquidity shares, when a fund needs to sell these shares, this would result in a level of loss that is much closer to the VaR portfolio assessment. This effect could be also present if third parties sell the lower liquidity shares in order to leave the market at a moment of correction.

5. Management performance measures based on asymmetry of probability distribution of returns

The results obtained by empirical analysis also show unambiguously the problems of applying **measures based on asymmetry of probability distribution of returns (Sortino ratio, Foster and Shutzer model, LPM-approach),** resulting from the limited liquidity of portfolios included in the portfolio.

As it was demonstrated, in the conditions of limited liquidity and growing market, assets manifest right asymmetry of their rate of return, which, other conditions being equal, will improve significantly the management performance measures, recording only "unfavorable" volatility (this "misleading" effect will be stronger for these measures than for measures using "overall" volatility, like Sharpe measure, for example). However, during the stage of market correction, when probability distributions of the rate of return become more symmetrical or acquire left asymmetry ("unfavorable" volatility increases), then there is a risk of incurring very high losses. Measures based only on the "unfavorable" part of volatility, however, will take into account such higher risk only afterwards, when losses are already incurred.

Conclusion

As a result of the analyses that have been carried out, we arrived at the conclusion that the popular classical management performance measures – the ones based on standard deviation of the rate of return or on its "unfavorable" part – Sharpe measure, Sortino ratio, etc., are not always reliable as measures of management performance, especially in the case of portfolios (parts of

total portfolios) based on low liquidity markets, including mutual funds portfolios in shares on such markets.

We saw how, in the conditions of limited liquidity, standard deviation does not always yield a sufficiently precise result with respect to the portfolio risk. We proved that standard deviation is related to liquidity, where lower liquidity shares have, other conditions being equal, higher standard deviation. Because of the more clear positive asymmetry of shares' probability distributions (higher probability of realizing profits above average) during a growing market period, Sharpe measure, based on standard deviation as a risk indicator, can indeed "overstate" management performance. The lower liquidity shares also manifest a higher positive asymmetry coefficient. During a transition of the market to a decreasing prices phase, the asymmetry of probability distributions of shares' rate of return shrinks and standard deviation starts reflecting more realistically the risk level. This is the risk, which stays "hidden" for Sharpe measure, with the respective consequences for the parameters related to the risk/return ratio of the portfolio.

As a shortcoming of Sharpe measure, we have also considered the fact that it does not account for possibilities of extreme losses for the portfolio, which are measured by VaR-analysis. We have also briefly mentioned some effects of liquidity on the applicability of the VaR-analysis and some potential effects of lower liquidity, which are not reflected by it.

Obviously, liquidity is an important problem in the assessment of management performance. Using statistical analysis, we proved the presence of a relationship between liquidity and, in general, the applicability of standard management performance measures. We proved that low liquidity can distort risk measures, which limits the applicability of indicators, in which these measures are used. It is true that the results of our statistical analysis have relatively low explanatory value and on the basis of the obtained models and formulas, it is not possible to forecast risk measures based on liquidity. It is, however, quite normal. Many factors influence risk measures and liquidity is only one of them. Besides, this was not the purpose of the analysis. Its purpose was to prove the existence of a distorting effect from the part of liquidity, to prove the relationship between liquidity and the used risk measures, to explore the strength of this relationship, its direction, and the contribution of liquidity to the explanation of differences in risk measures of different shares, which would be reflected by portfolios comprising them.

This analysis can be made considerably more precise by increasing the number of studied shares and the number of observations. In this way, the statistical significance of the results and their stability will both be higher. It is obvious, however, that the liquidity of shares in mutual fund portfolios should be reflected in the management performance measures, especially for portfolios containing shares traded on low liquidity markets. ИА