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Critical Analysis of the Sharpe Ratio: Assessing Performance and Risk in Financial Portfolio Management

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Abstract

The Sharpe Ratio, serves as a crucial tool in assessing the relationship between return and risk. This study proposes a critical analysis of the Sharpe Ratio, addressing not only its practical applicability but also its involvement in the decision-making process for investors and portfolio managers.

The aim of this research is to uncover the depth of interpretation of the Ratio, surpassing its simple use as an efficiency indicator. A detailed evaluation of the factors influencing the outcome of this ratio is proposed, along with an analysis of its impact on investment decisions. The primary objective of the study is to investigate thoroughly the components of the Sharpe Ratio and how they can provide a more nuanced perspective on performance.

This critical analysis makes significant contributions to understanding and applying the Sharpe Ratio in the complex context of financial markets, offering crucial insights for those involved in the investment decision-making process.

Key words: Risk-return, interest rate, performance, profit distribution, yield
J.E.L. Classification: A00

1. Introduction

The Sharpe Ratio (Basno C., Dardac N., 2000), also known as the reward-to-variability ratio, is a widely used metric in portfolio management. It is calculated by standardizing the portfolio's excess yield over the risk-free rate by its standard deviation.

Hypothetically, investors could always choose to invest in government bonds to obtain a risk-free rate of return. The Sharpe Ratio measures the expected return above this minimum. Within the framework of portfolio theory, which explores the relationship between reward and risk, it is anticipated that investments with higher risk should yield higher returns. Therefore, a high Sharpe Ratio indicates superior performance adjusted for the level of assumed risk.

According to the Sharpe Ratio, the performance measure represents the compensation per unit of risk. Quantified by the rate of excess return compared to the level of risk-free return. The higher this rate (s), the higher the portfolio performance is considered.

2. Theoretical background

In 1962, Markowitz presented his research on portfolio theory and the need for Sharpe's covariance calculations. Afterward, Sharpe published the work "A Simplified Model of Portfolio Analysis." Inspired by Markowitz's ideas, Sharpe proposed a more accessible mathematical method, thus avoiding the complexity of numerous specific covariance calculations.

Sharpe argued that all securities are correlated with a certain underlying factor, such as the stock market index, gross national product, or another relevant indicator for the evolution of security prices. In applying Sharpe's theory, an analyst only needs to assess the relationship between the security value and the predominant underlying factor, thereby simplifying the mathematical approach of Markowitz. According to Sharpe's theory, the underlying factor for stock prices that significantly influences their behavior is the stock market itself. Additionally, the industrial sector and specific characteristics of the respective stock are important but with a lesser influence.

The Sharpe Ratio is an indicator of the efficiency of a trading strategy or financial instrument, expressed through its numerical value. The higher this value, the more efficient the evaluated object is considered.

This measure provides information on how previous evaluations of returns with risk can influence and predict the level of potential profit stability. Frequently used by financial analysts, the Sharpe Ratio provides a comprehensive perspective in summary tables that offer an evaluation of financial assets. It is an essential tool for understanding the efficiency and stability of performance in the context of the relationship between yield and risk.

Calculating the coefficient provides the investor with a clear indication of the level of risk associated with a specific financial asset. The Sharpe Ratio calculation is performed using formula (1).

$$Sp = \frac{Rp-Rf}{\sigma}; \qquad (1)$$

- Sp = Sharpe ratio;
- Rp = the past portfolio return excess;
- Rf = risk-free rate of return on a financial investment;
- σ = standard deviation of the excess return concerning the risk-free rate.

In the process of calculating the Sharpe Ratio, the numerator uses mathematical expectations. As with any other coefficient, this indicator is dimensionless. In most cases, its data is compared with a benchmark, representing the risk-free interest rate of the asset's yield.

The Sharpe method measures the gain relative to volatility (Anghelache G., 2009). Using the Sharpe ratio, diversified structured portfolios can be classified, including the benchmark.

3. Research methodology

In the process of constructing an investment portfolio, it is imperative to perform a comparative analysis of different portfolios, requiring detailed knowledge of the quotations of all included securities (W.Sharpe, 1963). We have elaborated an example of the calculation of the Sharpe Ratio based on virtual companies.

Assume our portfolio includes three stocks represented by companies A, B, and C, with weights of 30%, 25%, and 40%, respectively. Although the data was extracted for one month, we recommend evaluating it over a more extended period for a comprehensive analysis.

Our goal is to highlight the components of the Sharpe Ratio and how it is constructed to later demonstrate our improvement methods. For calculating the Sharpe Ratio, the first step involves determining the returns over sub-periods of the investments, comparing them with a benchmark in the same sub-period, and then calculating the differences. Subsequently, the average of these differences is divided by the standard deviation. It is an essential process for evaluating portfolio performance and identifying potential improvements.

Table no. 1 Sharpe Ratio Calculation

No. Corp.	**Companies/Probabilities**			**Return**			**Portfolio Profit**	**Risk**
	A – 0,3	**B – 0,25**	**C – 0,4**	**A**	**B**	**C**		
1	245,28	3012,15	125,41					
2	243,25	3017,24	123,12	-0,9125	0,1688	-1,8428		
3	248,73	3007,88	128,27	2,2278	-0,3107	4,0977	-0,2909667	2,10836
4	241,12	3009,85	125,46	-3,1073	0,0654	-2,215		
5	238,16	3016,24	128,93	-1,2353	0,2120	2,7282		
6	244,37	2021,64	122,21	2,5740	-40,01	-5,3528		

7	245,11	3014,16	120,14	0,3023	39,941	-1,7083		
8	**COEFFICIENT**							**-3,9324**
9	**RISK-FREE ASSET RETURN**							**8**

Source: Compiled by the author based on information published on https://www.crystalbull.com/sharpe-ratio-better-with-log-returns/ [accessed on November 22, 2023]

As a result, the Sharpe Ratio is in negative territory, signifying that the portfolio is associated with a high level of risk and requires careful evaluation (Basno and Dardac, 1999). The return of a risk-free asset exceeds the portfolio's return, suggesting that it would be more advantageous for an investor to place funds in a bank with an 8% annual yield than to invest them in this portfolio.

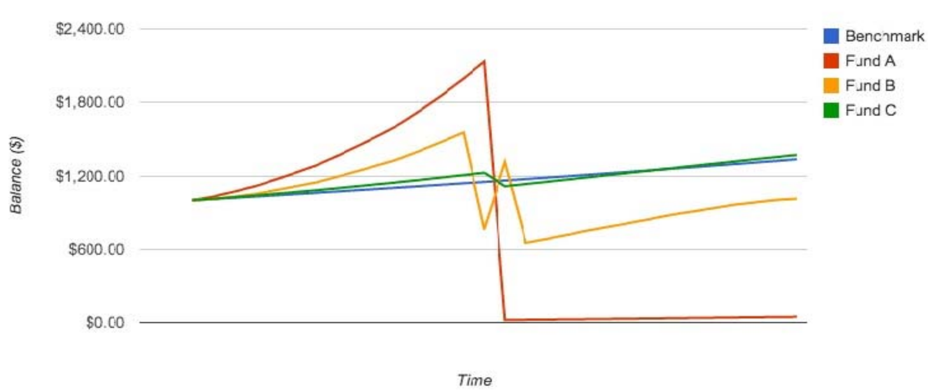
Why is this a potential issue?

Primarily because the use of a simple arithmetic mean (average) of return percentages can be misleading. Yield percentages are not additive. To illustrate, consider the following funds.

Fund 1	Periodic yields: 10%, 5%, -5%, -10%.	Average return: 0%
Fund 2.	Periodic yields: 90%, 50%, -50%, -90%.	Average return: 0%

These two funds would be extremely challenging to differentiate based only on the average yields. However, the actual yields are significantly different. At the end of the four periods, the total yield of Fund 1 is -1.25%, while the total yield of Fund 2 is -85.75%. In any case, the average yield does not reflect an investment in loss, and it fails to make any distinction between these two quite different funds. The calculation of simple arithmetic mean, in the context of percentage returns, can be highly inaccurate.

Figure no. 1. Percentage returns of companies A, B, and C



Source: Compiled by the author based on information published in Table no. 1

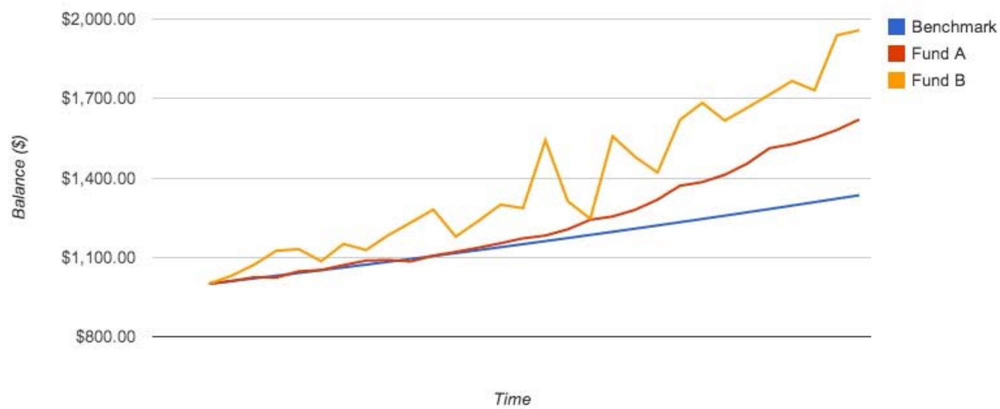
All three funds exhibit the same Sharpe ratios. Funds A and B show identical average differential yields, along with identical standard deviations. In the case of Fund C, we observe an average yield and standard deviation that are only 1/10th of the values of the other two funds. Unfortunately (Dănilă, 2000), as Sharpe arithmetic uses simple arithmetic means, we cannot highlight the distinction between these vastly different performances of the funds.

4. Findings

Next, we will present solutions to reduce the level of risk. In this respect, the question is which fund would you choose between these two funds?

Certainly, Fund A has never outperformed Fund B, but the Sharpe Ratio of Fund A is three times higher than that of Fund B. A fund manager who uses the Sharpe Ratio as the sole selection criterion would opt for Fund B. However, while limiting variability in a portfolio can be beneficial, this example underlines the challenge associated with using a single ratio as a measure.

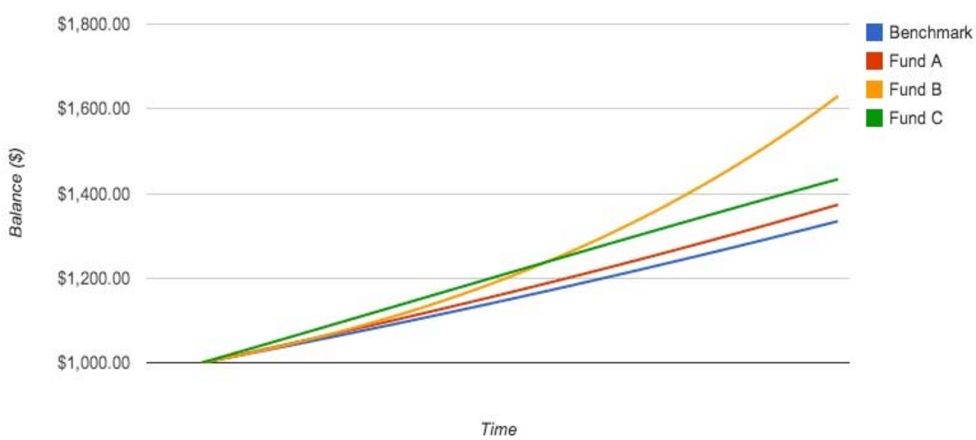
Figure no. 2 Portfolio Variability of Funds A and B



Source: Compiled by the author based on information published in Table no. 1

Changes at the numerator (yield) affect the ratio linearly, while changes at the denominator (standard deviation) impact it hyperbolically. This places greater emphasis on lower variability than on higher yields, which may not be in the investor's best interest. Additionally, an investor might choose two funds with high yields and significant variability but negatively correlated. This could add portfolio returns while simultaneously offsetting variability. Using exclusively the Sharpe Ratio does not facilitate the selection of such funds.

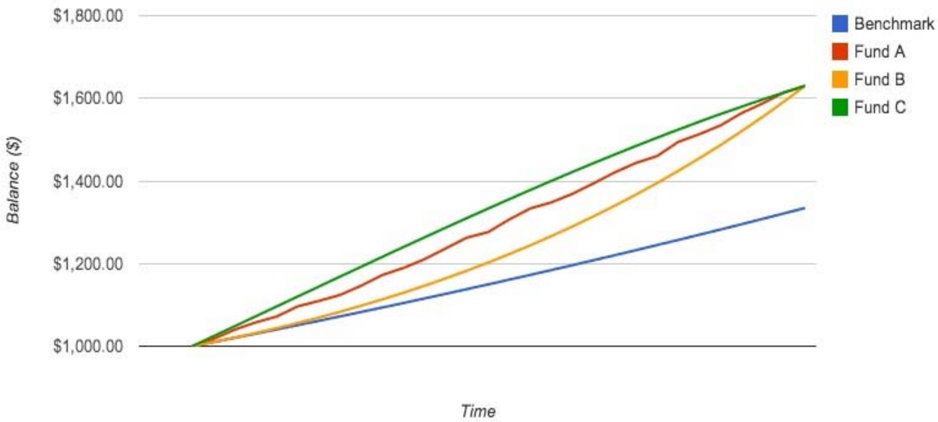
Figure no. 3 Variation of Funds A, B, and C. Solution for Risk Reduction



Source: Compiled by the author based on information published in Table no. 1

Fund A is characterized by extremely lower variability, generating a significantly higher Sharpe Ratio, approximately 33 times higher than that of Funds B and C. In contrast, Funds B and C exhibit identical Sharpe Ratios (Cetină I., Odobescu E, 2007). The key question here is why Funds B and C would present lower Sharpe Ratios compared to Fund A.

Figure no. 4 Funds A, B, and C - Identical Distribution of Returns



Source: Compiled by the author based on information published in Table no. 1

All three funds exhibit an identical distribution of yields. The periodic yields of Fund A are random, while Fund B displays identical periodic yields but arranged in an accelerated order. Fund C, on the other hand, adopts a decelerated order. Certainly, all of them have the same Sharpe Ratio because variability and standard deviation do not consider order.

The important question is: which of these funds might be more favorable in the future, and which is considered the riskiest? Many investors believe that in short sampling periods, yields are random, and prices move in a Brownian manner. Therefore, each of the presented yields would have equally likely alternative histories, with the same probability of occurrence. However, is it so?

Over the long term, prices and yields are not random; they are intentional. Countless hours of work are invested daily in efforts to increase capital prices, asset values, and securities. Without the correlation of results, humanity would have ceased to produce long ago. Although the yields of Fund A seem healthy, its variability could be explained by seasonality, temporary market changes, or random fluctuations (Reynolds, D. 2008). The yields of Fund C might also be random. However, noting that the managers and employees of the companies in this fund make every effort to increase earnings, the consistent decline in profitability is concerning.

It is a rational choice to reject Fund C, especially when there are funds available with more favorable growth tendencies. Fund B appears to be the most. The efforts of its participants succeed in raising rates of return. Thus, considering the possibility of a random movement, Brownian motion of returns, Fund B exhibits features favorable to successful growth and should be selected.

Regardless of the choice, the increase in the rate of return generates variation in the Sharpe Ratio, and variance is a proxy for risk in the Markowitz mean-variance paradigm. This variety should be considered less risky, not more. The detailed analysis of changes in the rate of yield of the second order exceeds the field of interest of this research paper and is dedicated to future continuation. The purpose of presenting this comparison is to underline how funds with different characteristics can exhibit identical average deviations and standard deviations of yields.

The main **solution** to the issue addressed is the **numerator**. A straightforward approach to address the issue with average yields mentioned above is to use compounded yields (Basno C., Dardac N., 2002). Instead of summing each periodic yield from t=1 to T, we could choose to take only the compounded yield at the end of the total period (t=T). Would this solve the problem? Each fund or security would be directly assessed with the total compounded yield recorded in that period. However, we aim to develop an evaluation method applicable to ex-ante decisions, where matching periodic yields with variance or using a Monte Carlo mechanism to determine probabilistic yields might be desired. For this reason, we intend to maintain the detailing of yields on sub-periods.

Exponential Growth
Calculating simple yields as we have done before is a straightforward process:

$$R = \frac{P_e - P_b}{P_b}, \quad \text{or}$$
$$R = \frac{P_e}{P_b} - 1$$

R	- Return (x100 = %)
P_e	- the price at the end of the period
P_b	- the price at the beginning of the period.

However, as we have noted before, periodic yields are not additive; the sum of returns for multiple periods does not reflect the total return over the entire period. Therefore, to determine the total return in period T, it is necessary to compound the growth for each sub-period, as illustrated here in a simplified form:

$$P_f = P_i(1 + R_n)^n$$

P_f	- final Price
P_i	- initial Price
R_n	- Rate of Return for each sub-period.
n	- number of sub-periods

5. Conclusions

The Sharpe Ratio represents the difference between the average yield of a portfolio and the risk-free rate, relative to the portfolio's volatility. This metric expresses the excess yield relative to the total assumed risk. In other words, the Sharpe Ratio quantifies the net performance of a portfolio in the context of the total assumed risk. A portfolio considered "risk-free" (such as an investment in Romanian government securities with an expected yield representing the risk-free rate) would have a Sharpe Ratio of 0 (zero). Generally, the higher the Sharpe Ratio value, the more attractive the risk-adjusted yield becomes. The Sharpe Ratio is calculated over 1 year, based on daily values.

The Sharpe Ratio assesses the performance of a portfolio manager by considering both the rate of return and the level of diversification (expressed through the standard deviation in its denominator). Therefore, this metric is more suitable for well-diversified portfolios as it more accurately captures the risks taken by the portfolio (Christmall P.M., Consumer B., 1995).

The Sharpe Ratio serves as a statistical measure of the stability of an asset or portfolio. It is important to note that, in situations where the investor wants to consider only the negative dynamics of changes in return, the Sharpe Ratio can provide a useful perspective on the portfolio's performance.

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