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The Statistics of Sharpe Ratios

Andrew W. Lo

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Abstract

The building blocks of the Sharpe ratio—expected returns and volatilities—are unknown

quantities. The estimation error. The Sharpe ratio is measured? To address the estimation of the Sharpe ratio, options for the return, returns, stationarity ratios cannot be annualized, and I derive the Sharpe ratio. In an illustration, the annual Sharpe ratio is because of the pres the annual correlation is properly change ratios can change. The building blocks are unknown quantities. estimation

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error. This raises the natural question: How accurately are Sharpe ratios measured? In this article, I provide an answer by deriving the statistical distributions of the usual Sharpe ratio estimator—sample mean excess return over sample standard deviation—using standard econometric methods under several different sets of assumptions for the statistical properties of the return series on which the ratio is based. Armed with these statistical distributions, I show that confidence intervals, standard errors, and hypothesis tests for the estimated Sharpe ratio can be computed in much the same way that they are computed for regression coefficients, such as portfolio alphas and betas.

The accuracy of Sharpe ratio estimators hinges on the statistical properties of returns (e.g., time-series properties, such as mean reversion, momentum, or time-varying volatilities). Although this may seem like a theoretical exercise best left for statisticians, there is often a direct connection between the investment management process of a portfolio and its statistical properties. For example, a change in the portfolio manager's style from a small-cap value orientation to a large-cap growth orientation will typically have an impact on the portfolio's volatility, degree of mean reversion, and market beta. Even for a fixed investment style, a portfolio's characteristics can change over time because of fund inflows and outflows, capacity constraints (e.g., a microcap fund that is close to its market-capitalization limit), liquidity constraints (e.g., an emerging market or private equity fund), and changes in market conditions (e.g., sudden increases or decreases in market volatility).

At a superficial level, the Sharpe ratio could depend on the investment style. More volatile investment strategies would yield Sharpe ratios that are smaller than those of less volatile strategies. However, as discussed in this article, the Sharpe ratio for mutual funds is not simply a function of the volatility of investment returns. The Sharpe ratio is also a function of the correlation of investment returns with the market. If, especially in the case of emerging market funds, the correlation of investment returns with the market is small, the Sharpe ratio will be small. In fact, the Sharpe ratio can be small even if the correlation of investment returns with the market is large. This is because the Sharpe ratio is a function of the correlation of the portfolio's returns with the market and the correlation of the portfolio's returns with the market's returns—can yield Sharpe ratios that are considerably smaller (in the



case of positive serial correlation) or larger (in the case of negative serial correlation). Therefore, Sharpe ratio estimators must be computed and interpreted in the context of the particular investment style with which a portfolio's returns have been generated.

Although the Sharpe ratio has become part of the canon of modern financial analysis, the results presented in this article suggest that a more sophisticated approach to interpreting Sharpe ratios is called for, one that incorporates information about the investment style that generated the returns and the market environment in which those returns were generated. For example, hedge funds have very different return characteristics from the characteristics of mutual funds; hence, the comparison of Sharpe ratios between these two investment vehicles cannot be performed naively. In light of the recent interest in alternative investments by institutional investors—investors that are accustomed to standardized performance attribution measures such as the annualized Sharpe ratio—there is an even greater need to develop statistics that are consistent with a portfolio's investment style. The empirical example in this article underscores the practical relevance of proper statistical inference for Sharpe ratio estimators: Ignoring the impact of serial correlation of hedge fund returns can yield annualized Sharpe ratios that are overstated by more than 65 percent, understated Sharpe ratios in the case of negatively serially correlated returns, and inconsistent rankings across hedge funds of different styles and objectives. By using the appropriate statistical distribution for quantifying the performance of each return history, the

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