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Performance Indicators of Mutual Funds

There are over 9,000 mutual funds in the market today. In an effort to seek overperformance, active investors use fundamental analysis to determine factors indicative of a fund likely to overperform. I seek to draw hypotheses from previous literature regarding the effect of quantitative factors on performance. I then review formulas and methods for determining relationships between indicators and future return. In doing so, I hope to find a formula that matches my data and test its reliability. Finally, I explain how I will utilize machine learning to ascertain the most suggestive indicators of the long-term future return of equity mutual funds.

Literature Review

Literature covering this topic has come to a wide range of conclusions. Since software can only interpret quantitative data, I limit my scope of possible indicators to persistence, portfolio turnover, expense ratio, and asset size. For each indicator, I look at studies that examined actively managed open-ended funds. I make a distinction between short-term and long-term return as the return less than one year and return more than one year, respectively. Overall, findings for each of these indicators is mixed, which is as expected. Different studies may have different definitions for what is considered a good indicator or may only choose mutual funds in a certain subgroup.

Researchers primarily use one of four formulas to analyze the previous performance of a fund: Sharpe ratio, Sortino ratio, Treynor ratio, and alpha. The Sharpe Ratio is the average return earned in excess of the risk-free rate per unit of volatility defined as standard deviation. Essentially, it captures the risk-return trade off or an investment (Sun et al. 11). The Sortino ratio is a variation of the Sharpe Ratio, but it instead assesses risk by distinguishing volatility caused by unfavorable returns (Fan and Mazumder 146). This method is generally used instead of the Sharpe Ratio when an investment has low risk. The Treynor ratio is also similar to the Sharpe ratio, but uses beta rather than the standard deviation as a risk measure, which cannot be eliminated through diversification (Verma and Hirpara 383).

Jensen's alpha, Jensen's measure, or simply alpha is used to determine the excess return of a portfolio over its theoretical expected return or a benchmark. Generally, theoretical expected return is calculated using the capital-asset pricing model (Verma and Hirpara 383).

The Sharpe ratio, Sortino ratio, Treynor ratio, and Jensen's measure are defined as:

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma_p} \qquad \text{Sortino ratio} = \frac{r_p - r_f}{\sigma_d}$$

$$\text{Treynor's ratio} = \frac{r_p - r_f}{\beta_p} \qquad \text{Jensen's alpha } (\alpha) = r_p - [r_f + \beta_p(r_m - r_f)]$$

r_p = asset return
r_f = risk-free rate
β_p = beta of portfolio
r_m = market or theoretical return

σ_p = standard deviation of return
σ_d = standard deviation of negative (downside) asset return

Persistence

The most widely studied indicator of both active and passive mutual funds is persistence (momentum) in return over periods ranging from a month to a few years. Previous literature regarding persistence has documented conflicting results. Some find weak or no persistence in actively managed mutual funds. For example, Evensky and Pfeiffer investigated persistence of alpha across business cycles over a period of 10 years. They found that previous outperformance displays weak persistence, and performance of the fund in a bull or bear market is not an indicator of a performance in future markets (Evensky and Pfeiffer 2).

In contrast, some studies find persistence up to seven years. Hereil et al. used ratings from Morningstar to determine persistence of ratings, which are calculated based on previous fund performance relative to similar funds (Morningstar). They found that persistence was existent for short periods, and was more pronounced for poorly performing funds (Hereil et al. 18). Asebedo and Grable studied both active and passive funds over 8 years to find that returns were persistent up to seven years. They found that persistence became less stable during the eighth and ninth year, but other indicators more indicative of overperformance during that time period (Asebedo and Grable 10). The mixed findings of persistence is seemingly not a reliable indicator of return.

Portfolio Turnover

Turnover is defined as the percentage of a portfolio that is sold within a given timeframe. Most literature seems to agree that high asset turnover is not desirable, but whether lower turnover is beneficial in all scenarios is debated. Shukla examined 458 mutual funds with a wide range of fees, weighting, and turnover ratios, to compare performance with and without turnover over a 7 year period. He found that although turnover generated excess return, it did not cover trading costs in periods up to 6 months (Shukla 345). Kaushik et al. found that lower asset turnover portfolios tended to outperform others with relatively higher rates over 11 years (Kaushik et al. 117). Asebodo and Grable studied fund performance over 11 years and found that high turnover had a significant negative impact for only the seventh to ninth year (Asebedo and Grable 10). Mekonnen found that over a five year period, “4.2% of the variance in risk-adjusted performance is uniquely accounted for by portfolio turnover, when mutual fund class type, fund longevity, and management turnover are controlled” (Mekonnen 97), but determined that turnover did not provide any significant variation for a one year period. Findings of previous literature are mixed, but most conclude that turnover is not desirable.

Expense Ratio

Expense ratios have drawn a great deal of attention with the release of the first index fund by Vanguard in 1975. Proponents of a high expense ratio argue that it attracts experienced fund managers and allows a manager to make trades more freely. On the other hand, opponents argue that although there may be some benefits, the possible alpha produced will not be enough to overcome the amount lost because of fees.

Many studies found that in general, a higher expense ratio was a strong predictor of underperformance (Asebedo and Grable 6, Fan and Mazumder 149, Kaushik et al. 117). Shukla found that there is a “positive relationship between excess returns and expense ratios,” which suggests that “the benefits of active management do not go to the mutual fund shareholders” (Shukla 345). Essentially, previous literature finds that steep expense ratios characteristic of an overperforming fund cancel out one another. Logically, for a closet index or underperforming fund, a high expense ratio detracts from the return even further.

Asset Size

There is also division over the effect of asset size (market capitalization) of a mutual fund on its performance. The authors of “CFA, MBA or Both: Further Evidence on Mutual Fund

Performance" and "Predicting Mutual Fund Over-Performance Over A Nine-Year Period" found that larger capitalizations had a positive impact on performance (Fan and Mazumder 149, Asebedo and Grable 10). On the other hand, Chen et al., Chan et al., and Kaushik all determined that fund size detracts from performance (Chen et al. 32, Chan et al. 13, Kaushik et al. 117). Bodson finds that "there exists an intermediary optimal size (between small and big), which maximizes mutual fund performance" (Bodson 170). From previous literature, it seems that asset size does not have a clear effect on performance.

Calculating Relationships

There are statistical measures and terms that are essential to understand many financial equations. Standard deviation is one measurements of a fund's volatility and is used to determine whether a data set is normally distributed. Oftentimes, a researcher will use a one-tailed or two-tailed test to ignore outliers not characteristic of a data set.

Another common characteristic of financial research is disproving a null hypothesis. The null hypothesis is a hypothesis that claims there is no statistical difference between two variables, while disproving it proves the alternative hypothesis. This is the hypothesis that claims there is a statistically-significant relationship between the two variables. A p-value is the probability of an event on a scale from 0 to 1. Kurtosis is the height and sharpness of a peak of a probability distribution relative to a normal bell curve. It is used to determine if a data set should have a tail, where the kurtosis of a normal distribution is 3 (Ghasemi and Zahediasl 489). Standard deviation and kurtosis are defined as:

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$$

$\bar{x}$ = mean
n = sample size

$$\text{Kurtosis} = \frac{\Sigma \frac{x-\bar{x}}{n}}{\sigma^4}$$

$\bar{x}$ = mean

σ = standard deviation
n = sample size

Shapiro-Wilk test

The Shapiro-Wilk test checks for normality of distribution of a data set. Although there are many others (e.g. Kolmogorov-Smirnov test, D'Agostino skewness test, Anscombe-Glynn kurtosis test), Ghasemi and Zahediasl recommended the Shapiro-Wilk test because it has better power to reject the null hypothesis (Ghasemi and Zahediasl 487). A test of normality is important because many formulas assume that a given data set is normally distributed. If two variables are proven by the Shapiro-Wilk test to not be normally distributed, it gives a researcher more knowledge into how he or she could best approach the problem, likely by using a nonparametric test. The Shapiro-Wilk test is defined as:

$$\text{Shapiro-Wilk (W)} = \frac{(\Sigma\, ax)^2}{\Sigma(x-\bar{x})^2}$$

$\bar{x}$ = mean
a =coefficients dependent on sample size generated from the covariances, variances and means

Correlation & Regression

Pearson correlation or simply correlation is an equation for measuring the strength of a relationship between two continuous variables. This is the most common method to determine relationships between indicators and future performance. Regression is an extension of correlation, but differentiates between a dependent and independent variable. Linear regression essentially draws a straight line through a data set that can be used to estimate future values. Correlation and regression are defined as:

$$\text{Correlation (r)} = \frac{1}{n-1}\Sigma\left[\left(\frac{x-\bar{x}}{\sigma_x}\right)\left(\frac{y-\bar{y}}{\sigma_y}\right)\right]$$

n = sample size

$$\text{Regression (Y`)} = a + bx$$

$$b = r\,\frac{\sigma_y}{\sigma_x} \qquad a = \bar{y} - b\bar{x}$$

σ = standard deviation

r = correlation coefficient
σ = standard deviation
$\bar{x}$ = mean of independent variable
$\bar{y}$ = mean of dependent variable

T-test, Z-test, & Analysis of Variance

The t-test, z-test, and analysis of variance are all methods of determining relationships between variables. The one sample t-test is a method that uses standard deviation and compares the means of the two groups to determine the probability of those results happening by chance and whether the results are repeatable. The z-test is a variation of the t-test. but it requires a normal distribution and is better suited for sample sizes greater than 30 (Sawyer E29). The t-test and z-test are defined as:

T-test (t) = $\frac{\bar{x}_1 \mu}{\frac{s}{\sqrt{n}}}$

$\bar{x}$ = mean
μ = mean of population
s = square root of standard deviation
n = sample size

Z-test (z) = $\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$

$\bar{x}$ = mean
μ = mean of population
σ = standard deviation
n = sample size

The Fischer analysis of variance test (ANOVA) is a method similar to a t-test that determines the result independent variables have on a dependent variable. ANOVA requires a normal distribution and can compare the three or more groups. Its two-way variation can be used when there are two independent variables. The multivariate analysis of variance test (MANOVA) is a variation of ANOVA is used when there is more than one dependent variable.

Calculating Expected Return

The following models are used to determine how a fund will perform in the future. These models are result of findings I have reviewed, and are simply interpretations of how to best qualitatively characterize a fund. By comparing different formulas, I hope to find one matches conclusions I come to and I can test its reliability. Each progressive model builds upon the previous with different approaches. Beta is a common measurement of sensitivity in these equations, similar to standard deviation. It utilizes covariance, how close a fund matches a benchmark, and variance, how far returns are from the mean. Beta, covariance, and variance are defined as:

$$\text{Beta } (\beta) = \frac{Cov(x,y)}{Var(y)}$$

$$\text{Covariance } (Cov) = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{n-1} \qquad \text{Variance } (Var) = \frac{\Sigma(y-\bar{y})^2}{n-1}$$

$\bar{x}$ = mean of mutual fund
$\bar{y}$ = mean of benchmark
n = sample size

Capital Asset Pricing Model

The capital asset pricing model (CAPM) tests risk-return relationship for securities. This is the original model for determining a theoretically appropriate required rate of return of an asset. An investor, therefore, can evaluate whether a stock is fairly valued when its risk and the time value of money are compared to its expected return. This model is by far the easiest and most widely used model, as it is simple and allows for easy comparisons of investment alternatives.

Fama-French Three-Factor Model

The Fama-French three-factor model describes the returns of a portfolio or stock with the returns of the market as a whole. When used, this model can explain as much as 95% of the return in a diversified stock portfolio. This model is essentially an expansion to CAPM, as Fama and French found that small caps and value stocks generally outperformed the market as a whole, so they added size and value into the original capital-asset pricing model (Kampman 8).

Carhart Four-Factor Model

The Carhart four-factor model is an extension of the Fama–French three-factor model that includes a momentum factor for asset pricing of stocks. This model was created because Carhart found short-term persistence in active mutual funds (Carhart 80). From the equations for each of these functions, it is evident that each progressive function builds upon the previous. The capital asset pricing model, Fama-French three-factor model, and Carhart four-factor model are defined as:

Capital asset pricing model = $r_f + \beta(r_m - r_f)$

Fama-French three-factor model = $r_f + \beta(r_m - r_f) + \beta_{smb}(SMB) + \beta_{hml}(HML)$

Carhart four-factor model = $r_f + \beta(r_m - r_f) + \beta_{smb}(SMB) + \beta_{hml}(HML) + \beta_{umd}(UMD)$

r_f = risk-free rate of asset
β = beta of asset
r_m = (expected) market rate
β_{smb} = beta of SMB
SMB = small (market capitalization) minus big
β_{hml} = beta of HML
HML= high (book to market) minus low
β_{hml} = beta of UMD
UMD = up minus down (winners minus losers)

Implementation

The goal of this paper was to find information relating to mutual fund indicators and future return. I plan on making a software that will qualify or disprove the claims made by others in this field. However, since true artificial intelligence is still in its infancy, only quantitative observations can be made, and even that is limited to the data it can be taught to read. Sources of data will primarily be gathered from API’s designed for trading such as ones provided by

Quandl, Alpha Vantage, Interactive Brokers, and Barchart. Since any data source may terminate at any moment in a fashion similar to Google Finance, I will incorporate as many as possible to both cross-reference one another and make up for any lack of information.

The software would gather information from available data sets and run experiments to determine correlation between a possible indicator and performance. To predict future outcomes, a linear regression study can be completed. In addition to this study, I will test passive and active managed funds against one another to determine if passively managed funds, particularly index funds, could and should be compared to their active counterparts. I believe in doing so, some information I gather will be relevant for evaluating exchange traded funds because they seek to follow an index mutual fund (Lettau and Madhavan 1). In doing these experiments, my study can add to current literature by proving or disproving the effect of persistence, portfolio turnover, expense ratio, and asset size on performance of mutual funds.

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