

A Quantitative View of Investment Choices

March 2016

We compare the history of 32 assets and investment strategies, and present two figures. We first show the classic chart of individual asset volatilities and returns; this is then contrasted with a second figure demonstrating their impact when added to a traditional stock/bond portfolio. We believe this second figure could be a more helpful tool for investors, with an emphasis placed on the methodology rather than the individual investments. Two conclusions are clear. First, it is useful to measure what we really want to know. Investors who are starting from a stock-bond portfolio and evaluating possible additions should be interested in different quantities from those choosing a single investment. Second, there is large uncertainty in the average characteristics of investment strategies, even when a comparatively long history is available.

The Risk/Return Profile

There is a broad range of asset classes for investors to consider; our study's investment universe was designed to sample from many of these classes, with a focus on assets likely to be known to the reader. Figure 1, overleaf, shows the historical annualized returns and annualized volatility, derived using monthly returns, for all 32 assets in our universe. For reference, we also show lines where various Sharpe ratios would lie using the return on US three-month Treasury bills as the risk-free rate. The risk/return profile is a common financial figure, and it is useful for quickly gauging an asset's basic characteristics.

To construct the figures in this brief, we used approximately 18 years of data from the inception of the Winton Futures Fund (WFF) for each asset¹, except for the S&P Volatility Arbitrage Index which uses only 15 years of data. Among the trend-following assets, WFF is shown twice²: once as it would have performed if the targeted risk had always been at today's lower level, and once using its real historical returns. In addition, 12 equities are shown: Apple and Berkshire Hathaway were selected because of their known historical success, and the remaining 10 were chosen randomly as

¹ Specifically, from October 1997 to December 2015.

² Both have had fees removed to simulate an investor's realized returns.

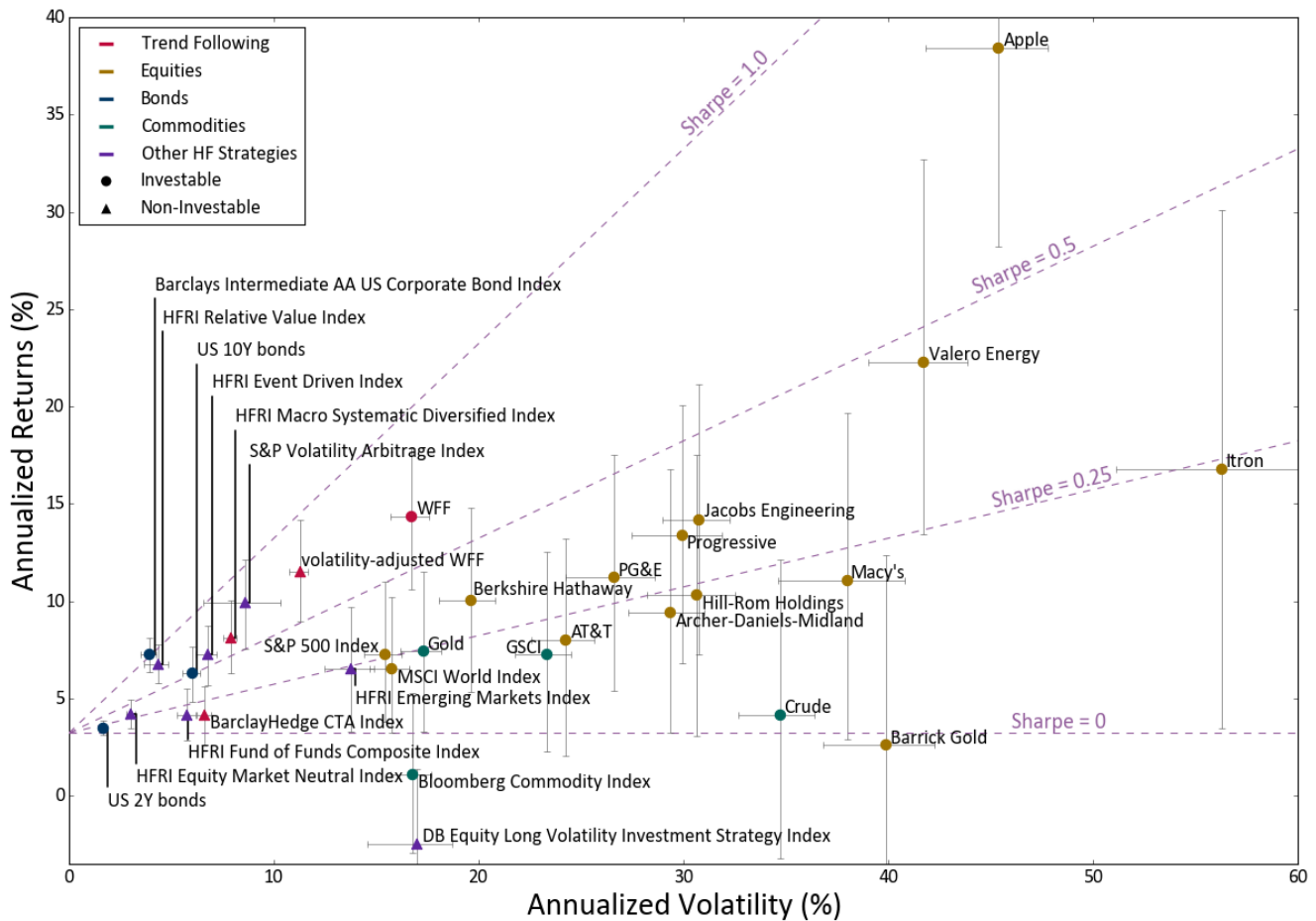


Figure 1: Annualized returns and volatility of our investment universe using 18 years of monthly returns. Error bars correspond to the 16th and 84th percentile determined via resampling each asset's returns. Sharpe ratio lines use US three-month Treasury bills for the risk-free rate.

representatives from each GICS sector in the S&P 1500 Index. Short descriptions of all 32 assets can be found in the appendix.

Error bars denote the 16th and 84th percentiles of the measurements, which is equivalent to approximately one standard deviation above and below the mean value for a normal distribution. This means we would expect a measured quantity to be within the associated confidence interval 68% of the time. These percentiles were determined by resampling the assets' returns. They reflect the sampling error: that is, the spread in measurements that we would expect from choosing a random 18-year period in a long history of a strategy with fixed average performance. The error bars do not include any allowance for changes in the characteristics of the strategies over time.

It is also important, for reasons discussed in the following sections, to distinguish between investable assets

(circles), and non-investable assets (triangles). Investable assets include those an investor could have invested in directly, or could have achieved similar risk/return characteristics through the underlying or derivative products such as ETFs. Non-investable assets are included since they are commonly referenced benchmarks, and increase the diversity of our investment universe. HFRI indices track the performance of hundreds of funds which would be difficult for an investor to recreate, or even impossible since some funds are closed to new investors. As for the other non-investable products, there are no investable products tracking them, and the volatility-adjusted WFF is a simulated product.

Portfolio Impact

Overall, Figure 1 shows how each asset or strategy has performed independently, but of more importance to investors is how an asset will affect overall portfolio

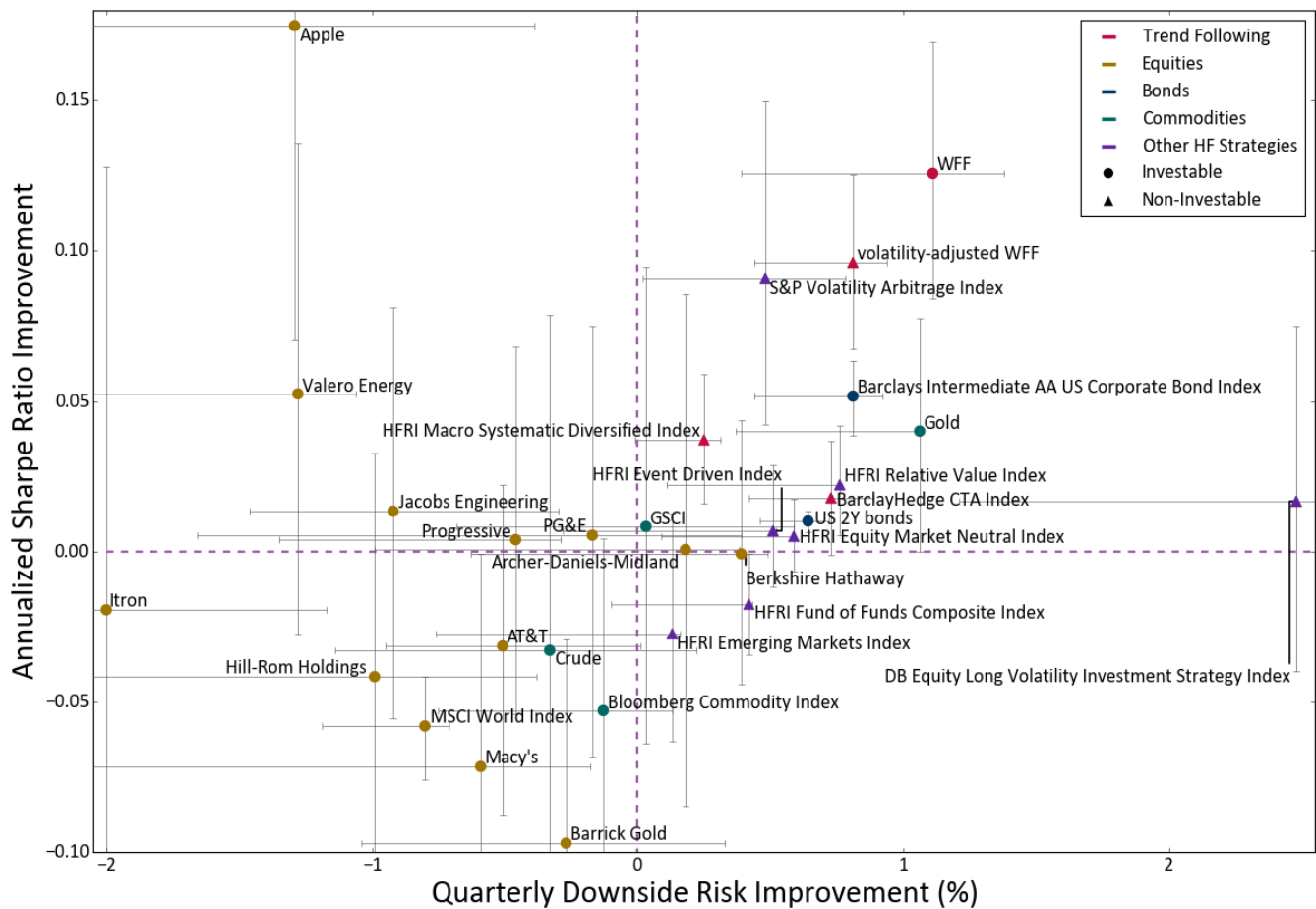


Figure 2: Sharpe ratio improvement and downside risk improvement, as measured by the difference between a traditional portfolio (60% stocks, 40% bonds) and an alternative portfolio (55% stocks, 35% bonds, and 10% of an asset from our investment universe). Results are based on 18 years of quarterly returns; error bars correspond to the 16th and 84th percentiles determined via resampling each asset's returns.

performance. Figure 2 attempts to quantify portfolio impact by comparing changes in the portfolio's downside risk and Sharpe ratio.³ To calculate these measures we constructed two portfolios: 1) a traditional portfolio composed of 60% stocks and 40% bonds, and 2) an alternative portfolio composed of 55% stocks, 35% bonds, with the remaining 10% allocated to an asset from our investment universe. The S&P 500 Index is used as a proxy for stocks, and US 10-year Treasuries are used as a proxy for bonds. There are only 30 assets shown in Figure 2 since we removed our stock and bond proxies.

We then calculated the annualized Sharpe ratios for both portfolios and took the difference ($SR_{alt} - SR_{trd}$) to measure the improvement from including an additional asset. The Sharpe ratio is a slightly misleading measure of portfolio

performance since it obscures the use of leverage to achieve returns, but it is a common statistic investors are familiar with. For downside risk, we measured the lower 5th percentile of each portfolio's returns. The difference between the alternative and traditional portfolios' downside risk ($DR_{alt} - DR_{trd}$) then determined the downside risk improvement. Both quantities were calculated using monthly returns with quarterly rebalancing. A quarterly downside risk measure is used since it is on a timescale more relevant to long-term investors. The traditional portfolio had a Sharpe ratio of 0.57 and a downside risk of -6.7%; the improvement measures were calculated with respect to these values.

³ Notice that the error bars in Figure 2 are not as symmetric as they were in Figure 1, this is an indication of non-normality.

Correlation, Error, and Bias

Figure 2 has been partitioned into quadrants to highlight portfolio impact characteristics that are meaningful to investors. Assets to the right of the vertical divide have historically reduced downside risk, while those on the left have increased it. Moreover, assets above the horizontal divide historically improved portfolio Sharpe ratios, while those below reduced them.

It is then clear that, should these properties persist into the future, assets located in the top right quadrant would be considered desirable additions to a portfolio, while those in the lower left should be avoided. Although, many assets' error bars span multiple quadrants which slightly blurs the distinction. A few observations are as follows:

- The location of the MSCI World Index within the lower left quadrant emphasizes the importance of strategically choosing global equities. It hints that, for this 18-year period, US equities outperformed global equities, but there is no reason to assume that this will continue for the next 18 years.
- Trend-following strategies perform well on both measures, and they have historically had a low correlation with equities and fixed income. This makes trend following a favorable choice for portfolio diversification.
- The S&P Volatility Arbitrage Index also performs well, but has some conspicuous features. In addition to not being directly investable, it also has had a higher correlation with stocks and bonds than trend following, and performed poorly during the financial crisis. For these reasons it may not appear to be a beneficial addition.
- The DB Equity Long Volatility Investment Strategy Index, on the far right of the plot, might be considered 'portfolio insurance' since it improves downside risk, but also lack exciting returns.

These kinds of inferences cannot easily be drawn from Figure 1. This is partially because the risk/return profile gives no indication of correlation between assets within a portfolio. Apparently similar investments in the risk/return profile can have vastly different effects on an investor's portfolio. For example, Archer-Daniels-Midland and Hill-Rom Holdings are positioned very close to each other in Figure 1, but in Figure 2 it's much clearer that Archer-Daniels-Midland would have been a superior portfolio addition to Hill-Rom Holdings. In fact, the two figures might lead one to draw different conclusions about certain assets' diversification potential. In contrast, the DB Equity Long Volatility Investment Strategy Index has negative annualized returns, but improves the portfolio Sharpe ratio the majority of the time. Part of the reason for these opposing conclusions may be attributed to the difference in time scales (i.e. annualized volatility versus quarterly downside risk); however, it is still the correlation between assets within a portfolio that is the main driver.

Correlation also plays a significant role in interpreting error bars. The error bars in Figure 2 are so large that it appears as though sensible comparisons between assets cannot possibly be made. However, when assets are correlated their errors no longer add in the usual way, and the error in the difference between measurements can actually be smaller than the error in either single measurement. The size of the error bars is a consequence of non-stationarity in the asset data and using only 18 years of data. The uncertainty associated with this historical data does not tell us about expected uncertainty in future returns.

Lastly, it is curious that all of the non-investable assets are on the right hand side of Figure 2. This is partly due to the unrealistic risk attributes of these hypothetical assets. But it is also perhaps an indication of the biases, such as selection and hindsight bias, which could be affecting hedge fund indices. Selection bias is a by-product of the index construction criteria, of which investability is a part.

Conclusions

Investors are faced with an ever increasing array of investment options, leading one to seek meaningful ways of making comparisons across classes and between assets. Our portfolio impact figure is an attempt to show how an investor could use quantitative measures to make such comparisons. We showed how correlation between assets in a portfolio can sometimes be more important than the performance characteristics of the individual assets, and we distinguished between investable and non-investable assets, the latter having an unfair advantage.

Our analysis was based solely on historical returns and may not be indicative of what will happen in the future. For example, evolving interest rates, fees, market correlations, and liquidity conditions will affect the various assets differently.

Appendix

Here we present short descriptions of the 32 assets included in our investment universe.

Bonds

- Barclays Intermediate AA US Corporate Bond Index: Intermediate AA component of the US Corporate Investment Grade index
- US 10Y bonds: Index of US government bonds maturing in 7 to 10 years
- US 2Y bonds: Index of US government bonds with up to two years until maturity

Commodities

- Bloomberg Commodity Index: Index tracking prices of futures contracts on physical commodities on the commodity markets
- Crude: Back-adjusted crude oil futures based on leading month contract
- Gold: back-adjusted gold futures based on leading month contract
- GSCI: Tradable commodity index owned by S&P and traded on the CME

Equities

- Apple: Large-cap information technology company
- Archer-Daniels-Midland: Large-cap consumer staples company
- AT&T: Large-cap telecommunication services company
- Barrick Gold: Large-cap materials company
- Berkshire Hathaway: Large-cap financials company
- Hill-Rom Holdings: Mid-cap health care company
- Itron: Small-cap information technology company
- Jacobs Engineering: Mid-cap industrials company
- Macy's: Large-cap consumer discretionary company
- MSCI World Index: Large and mid-cap index representing 23 developed market countries
- PG&E: Large-cap utilities company
- Progressive: Large cap financials company

- S&P 500 Index: Stock market index based on the market capitalizations of 500 large companies having common stock listed on the NYSE or NASDAQ
- Valero Energy: Large-cap energy company

Other HF Strategies

- DB Equity Long Volatility Investment Strategy Index: Tracks the performance of a long position in three-month-forward six-month variance swaps on S&P 500 Index
- HFRI Emerging Markets Index: Index tracking hedge funds that primarily invest long in securities of companies or in the sovereign debt of developing countries
- HFRI Equity Market Neutral Index: Index tracking hedge funds that employ quantitative techniques to determine future price movements between securities, in many cases portfolios are constructed to be neutral to one or multiple variables
- HFRI Event Driven Index: Index tracking managers who maintain positions in companies involved in mergers, financial distress, shareholder buybacks, etc.
- HFRI Fund of Funds Composite Index: Index tracking hedge funds with a diversified portfolio of managers
- HFRI Relative Value Index: Index tracking hedge funds predicated on the realization of valuation discrepancies between securities
- S&P Volatility Arbitrage Index: Bloomberg index that measures the performance of a tradable short variance swap strategy that is short implied volatility and long realized volatility

Trend Following

- BarclayHedge CTA Index: Equally weighted index of 500+ CTAs in BarclayHedge's database
- HFRI Macro Systematic Diversified Index: Index tracking hedge funds typically employing quantitative momentum models
- volatility-adjusted WFF: Winton Futures Fund returns adjusted to current risk level
- WFF: Winton Futures Fund

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