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Improving Portfolio Returns and Asset Allocations by Using Momentum and Volatility Metrics

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Abstract

Over the past decades, many practitioners and academic researchers have analyzed financial markets and have tried to identify robust methods for asset allocation and portfolio management. Modern Portfolio Theory, a theory that was developed by Harry Markowitz in the 1950's, has been widely accepted in the financial industry. The main objective behind the theory and model is to maximize portfolio returns for a given level of risk by constructing an efficient frontier.

While this theory has been a huge advance for mathematical modeling in finance, some of the assumptions this model presumes are unrealistic and do not match real-world characteristics of financial markets. While simplifying reality is completely acceptable in terms of modeling, many might criticize and wonder how helpful this model can actually be when tested in the real world.

In my research, instead of using conventional or accepted theories, I have looked at just two measurements, momentum and volatility, to see if these two metrics can help advise us on how to make better asset allocations.

Introduction

In financial markets, momentum is the idea that if a stock is currently performing well, then it will continue to perform well in the coming weeks or months. The same is true for the opposite case; if a stock is performing poorly, many may believe that the stock's performance will continue to do poorly.

Momentum has been described as one of the largest inefficiencies in financial markets. An efficient market is one where all pertinent information is available to all participants at the same time. Therefore, in the stock market, if it were truly efficient, prices would respond immediately to any information that becomes available. If this were true, momentum would not be able to persist in the market. However, we have identified that momentum does exist and there may be a possibility for gains if one is able to find a way to take advantage of it. Momentum will be used in the research to see if there are gains to building a portfolio that weighs heavily on assets that have great momentum.

Volatility is the next measurement that will be used in this research project. Volatility describes the movement or variability of an asset's price over time. If an asset's price has a tendency to change dramatically or often over a specific time period, we would classify that asset to have high volatility. On the other hand, many assets, like bonds, have low price variation. These types of assets would have low volatility classification.

Volatility can be a good measurement to use, since most investors naturally would enjoy having stable returns, rather than unpredictable outcomes. In this research project, we will also see if there are benefits to constructing a portfolio that uses assets with lower volatility relative to others.

Hypothesis

This research project's focus is to determine whether or not applying metrics like momentum and volatility truly have value when making asset allocation decisions. There are two portfolios that will be examined further in this paper: a high momentum and a low volatility portfolio.

With the momentum portfolio, I believe that portfolio returns may have greater returns than the traditional asset allocation[1], because the portfolio will select those that have the greatest momentum among all others in the selected pool of assets.

Low volatility portfolios may allow for more consistent returns since the portfolio will be made up of assets that tend to have stable prices. Although low volatility portfolios may not reap great returns, it may lead to much lower risk levels.

Methods

To test the hypotheses stated earlier, numerous back-tests were conducted and compared with the traditional asset allocation and the S&P 500. The pool of assets that were used to create portfolio included a variety of exchange-traded funds that focused on different types of asset classes in order to properly diversify the portfolio. The following funds in Table 1 are used for back-testing purposes:

Table 1

Fund Name	Category	Ticker
iShares Barclays 7-10 Year Treasury Bond Fund	Fixed Income	IEF
iShares Barclays 20+ Year Treasury Bond Fund	Fixed Income	TLT
iShares Core Total US Bond Market ETF	Fixed Income	AGG
Templeton Global Bond Fund Advisor Class	Fixed Income	TGBAX
iShares Barclays TIPS Bond Fund	Fixed Income	TIP
PowerShares QQQ Trust, Series 1	Domestic Equity	QQQ
SPDR S&P 500 ETF Trust	Domestic Equity	SPY
Vanguard Total Stock Market ETF	Domestic Equity	VTI
iShares Trust S&P Midcap	Domestic Equity	IJH
iShares Russell 2000 Index	Domestic Equity	IWM
iShares MSCI EAFE Index Fund	International Equity	EFA
iShares MSCI Emerging Markets Index	Emerging Markets	EEM
iShares Dow Jones US Real Estate	Real Estate	IYR
SPDR Gold Trust	Alternative	GLD
Kinder Morgan Energy Partners	Alternative	KMP

Each portfolio is constructed using *Solomon*, a software program developed specifically for this research project. *Solomon* uses daily stock prices and calculates the momentum and volatility for each asset given in the table above. Once those calculations are made,

[1] The traditional asset allocation portfolio is based on a 70/30 allocation in which 70% of a portfolio's funds are allocated towards equities and 30% of the remaining funds are allocated towards bonds.

depending on which type of portfolio is being constructed, the program will select the appropriate assets and test it over the specified time period.

Momentum and Volatility Calculations

Momentum is calculated by taking the current price of an asset and subtracting the price from an earlier time period. The calculation would follow as:

$$\text{Momentum} = \text{Price}_{\text{Today}} - \text{Price}_{\text{X Days Ago}}$$

This will give us the absolute momentum for a given asset. However, it's important to calculate momentum on relative basis in order to compare assets to one another. Therefore, a rate of change calculate will be used:

$$\text{Rate of Change} = \text{Today's Price} \,/\, \text{Closing Price X days ago}$$

Volatility is calculated by taking the standard deviation of the daily returns over a given time period. If one were interested in the volatility based on the last 30 days, the program would calculate the standard deviation of the daily returns over the past 30 days.

Steps in Portfolio Construction

In order to back-test using these two metrics, the software program needs to know the time periods and amount of assets to choose. It also needs a specified look-back period for each metric being used and a rebalance period. The following is a list of steps that indicates how the portfolio is initially constructed:

1. Set an initial portfolio value and back-testing time period
2. Determine the asset pool[2]
3. Select the metric to be used (momentum or volatility)
3. Determine the look-back period[3] for the selected metric
4. Specify the rebalance period[4]

Once the appropriate information and time periods have been indicated, the program will determine the asset allocations and indicate the return results during the given time period.

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[2] The asset pool that will be used in this project are the funds indicated in Table 1.

[3] Look-back period is the time period of data the program will be analyzing. A 30-day look-back period means that momentum or volatility will be calculated based on the last 30 days.

[4] Rebalance period is the time interval in which the portfolio will be readjusted. A 30-day rebalance period specification will make the program reassess the asset allocations every 30 days. In other words, the software will ultimately start the portfolio construction process every 30 days.

5-Year Example

Below is an example of one 5-year back-test using both high momentum and low volatility strategies compared to a traditional asset allocation and SPY.

Initial value: $10,000
Time Period: 1/1/2008- 12/31/2012
Asset Pool: IEF, TLT, AGG, TGBAX, TIP, QQQ, SPY, VTI, IJH, IWM, EFA, EEM, IYR, GLD, KMP
Rebalance Period: 30 days

High Momentum Portfolio: Top 7 assets, 60-day look-back period
Low Volatility Portfolio: Lowest 7 assets, 30-day look-back period

Figure 1

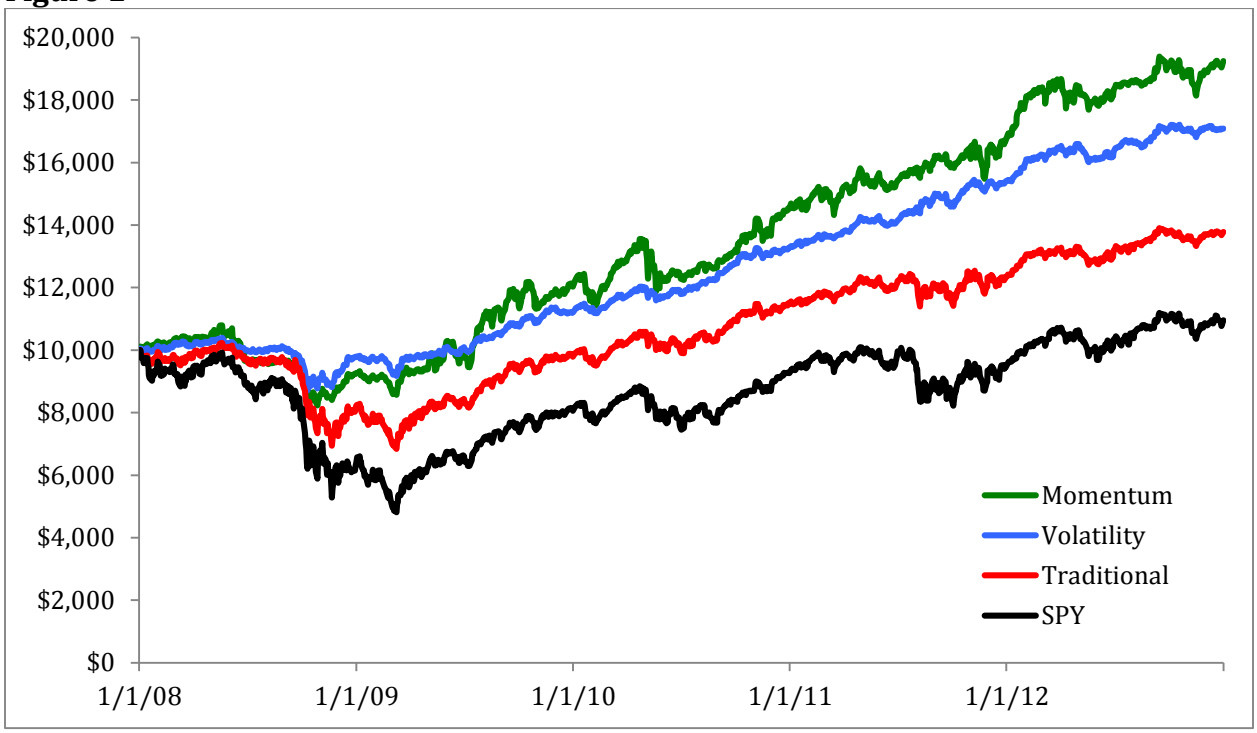

Table 2

Portfolio	Total Return	CAGR[5]	Max Drawdown[6]	Worst Year Return
Momentum	92.525%	13.289%	-23.678%	-8.164% (2008)
Volatility	70.834%	10.939%	-16.118%	-2.545% (2008)
Traditional	37.813%	6.630%	-33.119%	-17.778% (2008)
SPY	9.559%	1.844%	-51.874%	-36.234% (2008)

[5] CAGR stands for compound annual growth rate.

[6] The maximum drawdown is a measurement of the greatest peak-to-trough decline over the portfolio's time period. For example, if a stock climbed to a new all-time high of $50, but started to decline, then the drawdown would be calculated by finding the lowest decline from the $50 until it reaches a price greater than $50.

As you can see in Figure 1 and Table 2, both the high momentum and low volatility portfolios outperform the traditional portfolio and S&P 500 index in terms of both return, but also risk. Risk can be analyzed in many ways; often times a portfolio's risk is evaluated by reviewing its beta or standard deviation. However, in this research project I have chosen to focus on the maximum drawdown an investor would experience in the given time frame.

Maximum drawdown is essential to note, because not all investors operate rationally. When drawdowns become more and more significant, many investors may begin to fear their positions in the market and ultimately default all their holdings into cash rather than enduring market downturns.

The problem with exiting the market during a financial crisis or economic downturn is that most investors will naturally exit at a loss and possibly a large one. This ultimately causes the investor to have lower returns over the period and his future investments will have to perform even greater in order to recover from those losses. Making such a recovery can almost be impossible in such a small time frame and could possibly take many years in order for an investor to start seeing his portfolio's value approach the same levels as before the market downturn.

With lower maximum drawdowns, an investor may be more tolerable towards short-term losses and may choose to continue to stay in the market. Past studies have shown that markets tend to be resilient over longer periods, and it is also true for this one 5-year example. Therefore it can be rather advantageous to stay in the market and make an effort to cope with short-term losses.

Although an investor may never fully know how low their portfolio value will go in real-time, an investor that only experiences a 10% drawdown over the course of a month will most likely be more optimistic about the future than an investor that has already seen a 30% or 40% drawdown.

In this 5-year example, notice how the low volatility portfolio has the lowest maximum drawdown. This is somewhat expected since this portfolio selected assets that have low price variability and most likely chose to hold more bonds during the 2008 financial crisis. Also notice how its worst year return, which happened to be 2008, came out to be a slight loss of -2.545%. Although this is still a loss, it's a much lower loss in comparison to the traditional portfolio's loss of -17.778% in 2008.

The low volatility portfolios also has a much more smooth curve than the three other portfolios. This ties in with the fact that it has lower drawdowns than the other portfolios, and can be very favorable to investors that seek consistent returns rather than large returns with possibility of great losses.

On the other hand, the high momentum portfolio shows the greatest total return. While it does exhibit greater drawdowns than the volatility portfolio, it ultimately performs the best in the long-term horizon. This is also expected, since the high momentum portfolio selects assets that are performing better than the others in the chosen pool of assets.

Results and Analysis

The previous 5-year example shows some impressive and convincing results. However, testing over different time frames and time periods is essential in order to accurately assess the performance of portfolios using the momentum and volatility measurements. Often times, a portfolio may reap high returns based on the day an investor entered the market. When it comes to finding the right strategy, it is key to know that the strategy is robust and will continue to outperform regardless of the time period and/or time frame.

Below are the averages for return, CAGR, and max drawdown from a set 1, 3, and 5-year tests:

Table 3 – Average Statistics for 1-Year Back-Tests

Portfolio	Total Return	Max Drawdown
Momentum	18.425%	-10.15%
Volatility	11.143%	-5.550%
Traditional	9.309%	-12.406%
SPY	6.687%	-21.371%

Table 4 – Average Statistics for 3-Year Back-Tests

Portfolio	Total Return	CAGR	Max Drawdown
Momentum	66.566%	18.562%	-11.699%
Volatility	41.945%	12.932%	-5.8252%
Traditional	40.740%	11.899%	-18.319%
SPY	31.874%	9.217%	-31.162%

Table 5 – Average Statistics for 5-Year Back-Tests

Portfolio	Total Return	CAGR	Max Drawdown
Momentum	106.617%	14.850%	-23.572%
Volatility	65.684%	10.287%	-13.605%
Traditional	46.349%	7.920%	-33.527%
SPY	32.82%	5.850%	-51.484%

From the above tables, it seems more apparent now that regardless of the back-testing time period length, that the momentum and volatility portfolios continue to outperform the traditional and SPY benchmarks.

Like in the 5-year example test discussed earlier, both the momentum and volatility portfolios display the same traits in other time periods as well. The typical momentum portfolio will often reap higher returns, but also have greater risk, although not as great as the traditional portfolio. The volatility portfolios on the other hand, have returns close to the traditional portfolio and SPY benchmark, but exhibit much less risk in terms of drawdowns.

Conclusion

Through the work and results of this project, it seems that momentum and asset volatility can have a tremendous effect on a portfolio's return and asset allocation. The initial hypothesis was that momentum would demonstrate higher returns than the traditional portfolio due to the fact that it only selects the assets with the highest momentum. This proved to be true in the series of tests conducted.

With volatility, the hypothesis was that the portfolio would exhibit lower risk levels than that of the traditional portfolio. Not only did the volatility portfolios produce lower risk, but they also seemed to realize even higher gains than the traditional portfolio. This especially is an impressive result, since many investors would enjoy having investments with high yield *and* low risk.

Further Research

In this project, the main focus was on momentum and volatility measurements. In the future, asset allocations (other than an equal weighting which was applied through all the tests in this project) should be incorporated into the process. There are many other ways to allocate among the selected assets besides an equal weighting. These include: minimum-variance, minimum-correlation and volatility-sizing allocations.

Another aspect to research further is the amount of assets to select. In this project, the selection number was always the highest or lowest 7 assets. However, there may be a more optimal number of assets to choose from based on the pool of assets chosen.

Lastly, there are many times when one portfolio (momentum or volatility) will perform better than the other. Usually momentum performs best overall, but during market downturns, the low volatility portfolio often outperforms for a brief time period. It may be interesting to see if there is a way to know when to change strategies (from a momentum to a volatility portfolio or from a volatility to a momentum portfolio).

Works Referenced

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