# THE INVESTMENT PERFORMANCE OF A TACTICAL ASSET ALLOCATION STRATEGY BASED ON ECONOMIC INDICATORS AND PRICE MOVEMENTS

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**ABSTRACT**

This paper examines the investment performance of a tactical asset allocation strategy that uses four indicators as determinants of asset allocation between equity (S&P 500 Total Return Index) and fixed-income (Barclay's Capital Aggregate Bond Index) instruments. The indicators are split into two categories; buy (increase equity holdings) and sell (decrease equity holdings) indicators. When a specific criterion for each indicator is reached, a change to the asset allocation is effectuated for the following month. The findings suggest that with a moderate level of indicator success, substantial gains in returns are possible over the buy-and-hold strategy over a thirty year period. Furthermore, the results show a lowered average standard deviation in all cases over the 10, 20 and 30 year time horizons, indicating that an improved risk to return relationship is possible with tactical asset allocation using economic indicators as market timing signals.

**KEYWORDS**

Investment Strategy, Tactical Asset Allocation, Inversion of the Yield Curve, Market Timing, Price Movements

## 1. INTRODUCTION

Given the severity of the recent stock market correction and its impacts on investment returns, some investors have begun to question the effectiveness of conventional investment strategies that have effectively rendered "no returns for Buy-and-Hold investors since the late 1990s" Ripoll (2009). When factored with the emotional rollercoaster that investors must follow along the ups and downs of a Buy-and-Hold strategy, it is only natural for the curious mind to question whether there could be a better way.

Consider the following: an individual invests $100 that subsequently loses 50 percent of its value. For this individual's investment to grow from the $50 back to the break even of $100, it must now grow by 100 percent. Conversely, consider a second investor who held cash during the down market (-50 percent) and had invested fully during the up market (+100 percent), the second investor would be sitting with $200 versus the first investor that has just reached breakeven. Thus, when considering the severity of market corrections, would it be possible for an investor to take part in the gains of the stock market, while avoiding the corrections?

Tactical asset allocation (TAA) is an investment strategy that attempts to do just that. By allocating assets to equities while markets are expected to rise and holding fixed-income assets when they are expected to fall, an investment manager employing a TAA strategy hopes to avoid the pitfalls of a bear market, while riding the high tides of a bull market. Several studies including Sorensen & Arnott (1988), Vandell & Stevens (1989) and Weigel (1991) have shown that following Tactical Asset Allocation (TAA) strategies can provide better returns than the conventional Buy-and-Hold strategy over the long run despite the considerably higher transaction fees of the TAA approach as long as there is a fair amount of accuracy in the timing of the asset allocation change.

In the words of Shakespeare's Hamlet, "Ay, there's the rub". How does one determine the appropriate time to change the asset mix and move from equities to fixed-income, or from fixed-income over to equities? The study of *when* to buy or sell is known as *market timing*. If one could accurately predict the peaks and troughs of the stock market and set the asset allocation accordingly, the results are staggering as highlighted by Droms (1989).

With the allure of potentially increasing returns and lowering the level of risk, our focus turns to determining the appropriate time to change the asset class, also known as market timing. In an effort to quantify

the decision making, indicators are used to help an advisor determine the specific time to buy and sell. Research has been conducted to test the ability of a variety of indicators. Their success rates vary about as much as the types being tested as they range from mathematical indicators, such as dividend yields to emotional indicators such as investor sentiment.

This study uses four indicators to guide its tactical asset allocation strategy that have been subdivided into two distinct categories, buy triggers and sell triggers, which will be discussed in length in the methodology section of this report. Specifically, the yield curve is used as an indicator along with historical stock market data from the S&P 500 Total Return Index. In effort to evidence the relative success rates of these indicators, a thorough results table is presented in section 2.2. The goal of this study is to determine the effectiveness of these indicators in providing better returns than a buy-and-hold strategy, gross of fees, taxes and transaction costs.

This paper is structured as follows: section 2 contains a review of the relevant literature, section 2.1 discusses the data and the methodology while the results and their analysis are presented in section 2.2. Finally, the conclusions of the study are offered in section 3.

## 2. BODY OF PAPER

Two major areas of study are fundamental to this research: asset allocation and market timing. The body of literature on both topics is extensive. In particular, asset allocation became the topic du jour following the publication of the controversial study by Brinson, Hood & Beebower's (1986) entitled "Determinants of Portfolio performance". The study attempted to quantify the importance that the asset allocation policy has on volatility when compared to market timing and security selection. Asset allocation is the active decision making process of determining how much is to be allocated to the various asset classes, such as equities (stocks), fixed-income (bonds) or cash (t-bills). By examining data from ninety-one pension plans over a ten year period, they attempted to isolate which of the three factors had a bigger impact on volatility of returns. Their study revealed that asset allocation "explained on average fully 93.6 percent of the total variation in actual plan return" over a quarterly assessment of variation. They thus concluded that although market timing and security selection were important parts of the investment decision process, ultimately the investment policy design should receive the most consideration as it has the biggest impacts on return variability. A few years later, Brinson, Singer and Beebower (1991) revisited the 1986 study with an update as well as an extension to the modality. Incorporating data from 82 pensions plans studied between 1977 and 1987, they revised their figure to 91.5 percent of variation. Further analysis of asset allocation has sparked the interest in a second field of study, the aim of which was not to reduce volatility, but rather to increase returns through the effective allocation of assets to the better performing asset class through various cycles.

Over the last 70 years, fixed-income asset and stock asset classes have been demonstrated to have a negative correlation as demonstrated by Ilmanen (2003). These results were determined by means of a correlation analysis staggered over multiple periods of study. The main results of the study were that although the two asset classes had a tendency to move in correlation during the first part of the century, more recent data has shown a strong decoupling of this correlation, in particular during times of economic uncertainty. The net results are that generally speaking, when equities fall in value, fixed-income investments have a tendency to rise. Given this knowledge, some investment managers employ a strategy of changing the asset allocation mix at various times in the investment cycle by attempting to hold equities while they rise and switch to fixed-income before equities begin their fall. This strategy of tactically changing the asset allocation mix in attempt to improve returns is known as tactical asset allocation. Droms (1989) shows that by holding cash during years of decline in stock market prices and holding equities during up markets versus a pure Buy-and-Hold strategy on equities, an investor could produce additional returns of up to 6.47 percent per year over a sixty-year period. With the possibility of potentially increasing returns while reducing volatility, a large number of studies on TAA matter have been published with an incredibly varied amount of indicators tested for their accuracy. Among them the milestone paper of Fama & French (1989) that examines the impacts of changing the asset allocation throughout the business cycle in an attempt to improve returns. This was achieved by verifying the correlation between the business cycle and that of the stock market. By establishing a measurable correlation, they were able to

determine the possibility of using the business cycle to guide an investor in determining future stock market movements. Several years later, Brocato & Steed (1998) produced a very important study on the merits of an investment strategy that shifts asset allocation at various stages in the economic cycle. By assessing the results of this post-hoc tactical asset allocation strategy, they are able to prove the effectiveness of successful market timing allocation between various asset classes. Following in those footsteps, Jensen & Mercer (2003) produced a research paper that tests a system on a more commonly available and determinable variable: the turning points of the monetary cycle all of which prove to be successful indicators for tactical asset allocation. The study was extremely successful in helping to guide investment policy according to post-hoc evaluation. Other research was conducted on the use of the yield curve as a predictor to future economic volatility. In particular, its effectiveness as a leading indicator for economic recessions were verified by Estrella & Mishkin (1996) who showed that the size of the spread strongly influences the probability of a recession in the coming months. Attempting to capitalize on the success of the yield curve in predicting market volatility, Resnick & Shoesmith (2002) published "Using the yield curve to time the stock market" in which they tested the results of an investment strategy that moved between stocks and t-bills based on the yield curve. The results showed that an economically significant additional return could be generated by using the yield curve as an indicator over a forty-year period. In an effort to gauge the required effectiveness of any market timing signals, Clarke, Fitzgerald, Berent & Statman (1989) attempted to define the statistical significance required for a signal to produce positive results. Their study showed that as long as the market timing strategy falls within an R2 of 0.09, the market timing efforts proves beneficial. In his study on the effects of market timing, Sharpe (1975) came to a more pessimistic figure of a 70 percent required accuracy of effective market timing to boost returns, but nonetheless found that significant improvements to the risk/return ratio were possible. Many studies have been conducted on the effectiveness of a myriad of indicators in an attempt to determine and isolate a strategy that consistently provides an investor employing a tactical asset allocation strategy a signal to buy or sell the various asset classes. In particular, the Prather & Bertin (1998) study on the use of the discount rate as an indicator proves it to be highly effective in improving the risk-to-reward relationship for investors. Other studies, such as Nguyen & Roberge (2008) based on the presidential election cycle and the inversion of the yield curve as indicators also confirms the potential for increased returns with less risk for an investor who employs a tactical asset allocation strategy over a Buy-and-Hold strategy.

It is clear that there exists an extensive body of literature supporting tactical asset allocation as an investment strategy while a wide variety of indicators have been evaluated as determinants to market timing decision making.

## 2.1 Data and Methodology

In attempt to prove the efficacy of the tactical asset allocation strategy, this study will back-test the system from 1980 to 2010 providing results over ten, twenty and thirty year periods. The monthly data upon which this study will be based is divided into three parts: equities, bonds and the interest rates.

The Standard & Poor's Total Return composite index (S&P500TR) will be used to reflect a diversified investment in the equity arena. The S&P500TR is a capitalization-weighted index composed of the 500 largest and most widely traded stocks in the United States. An investment in this index represents a well diversified investment in large-cap stocks in the United States and tracks the reinvestment of dividends. As such, the defined allocation to equity will always reflect a full investment into this index, net of fees. This is to allow for proper comparison to a Buy-and-Hold strategy of the index, which would need to be subjected to a similar amount of fees for a typical investor. The data was obtained from the Standard & Poor's index data webpage with the help of its support staff.

Formerly known as the Lehman Brothers Aggregate Bond Index, the Barclay's Capital Aggregate Bond Index (the Agg) is a capitalization weighted index composed of the largest and most widely traded bonds on the market place with a fair allocation to a wide variety of bonds with a variety of lengths and duration. Although the

index has only been in existence since 1986, the data has been backfilled to 1976, thus satisfying our need for 30 years of data. As this represents a good allocation to the bond environment, this index will represent the bond component of the asset allocation. The data was obtained via email correspondence with a member of the Barclay's index team.

To identify month's in which the yield curve is inverted, a comparison between the interest rates on the United States Federal Reserve 90-day treasury bills is compared to the prevailing interest rates of the United States Federal Reserve 10-year bonds. As discussed in the review of literature, this has historically been a fairly successful leading indicator of future economic contraction. The data was obtained from the Federal Reserve's website.

### 2.1.1 Methodology

This portion of the study will define the parameters of the tactical asset allocation strategy. The study focuses on the inversion of the yield curve as well as the past performance of the S&P500 Total Return Index (heretofore known as S&P500TR) as its primary indicators. Indicators are used to trigger asset allocation changes and are divided into two parts: buy (increase equity) triggers and sell (decrease equity) triggers. When either of these two triggers is met, a change to the asset allocation occurs by a pre-determined amount.

#### 2.1.1.1 Buy Signals

Let us first examine the signals that would cause the buy signal to be triggered. Two separate tracking algorithms are employed to determine whether it is a good time to buy. The first is based on the most basic tenet of investing: buy low, sell high. This can best be determined by recent performance of the stock market. Should returns be negative for several months in a row, one could determine the price is currently lower than it was, and thus could use this as a potential signal to enter the market to some degree and take advantage of a potential buying opportunity. To help identify such cases, the following equation is employed:

if ( geometric return of the last three months is < * ) then trigger Buy1

In other words, if the geometric returns of the last three months of the S&P500TR index shows a negative return of *% or more, then trigger buy signal 1. Three values for * were selected to determine what range is most effective. This study will compare a 10% loss, a 15% loss and a 20% loss to determine which of these triggers would have been the most effective over a given time period. As the % drop represents a significant correction in stock market prices, it may present a good time to purchase, and thus will be tested. To minimize repetition of the signal, it can only be triggered if it has not been set off in the last three months.

A second buy signal uses the stock market's recent volatility to determine market opportunities. As any market historian can attest, bear market corrections on the stock market are usually considerably more violent and volatile than standard moving markets. This can be attributed to the herd mentality of investors as well as the potential for margin calls to exacerbate the closing of positions to maintain solvency. Regardless of the cause, if the markets experience considerable volatility in a short time span, it could signal a potential buying opportunity as prices are pushed unreasonably low. To determine such buying opportunities, a second buy signal has been developed that is set off when the markets experience outstanding volatility. The second signal is defined as follows:

if ( the $\sigma$ of at least one of last three months of returns is > * $\sigma$ of S&P500TR ) then trigger Buy2

Elaborated, this tells us that if within the last three months, there has been a month where the standard deviation of the returns is * times greater than the standard deviation of monthly returns for the S&P500TR over the last 30 years, then trigger buy signal 2. This study will test 2, 2.25 and 2.5 times the standard deviation in an attempt to determine which of the impact of this variable. The change to the asset allocation occurs when one or

both signals are triggered. The specifics of the changes will be discussed in the asset allocation modification portion of this document.

#### 2.1.1.2 Sell signals

Similarly, a sell signal is triggered by one of two tracking algorithms hereto known as sell signals. The first of the two signals uses a trend analysis to determine whether a modification to the asset allocation is appropriate. Once again, an ongoing analysis of monthly market data of the S&P500TR is examined and used to determine whether the stock market has shown a long term positive trend. A positive trend is determined by the number of months where the markets returns were positive. As soon as the number of month's with positive returns within the last year reaches *, then a sell signal is triggered. This signal cannot be triggered more than once every twelve months. For the purpose of this study, 9 months, 10 months and 11 months will be tested as appropriate time periods of positive markets within which to signal buying opportunities. The formula is defined as:

if( # of positive months in the last year is > * ) then trigger Sell 1

The second sell signal is the conditions prevailing in the treasury and bond markets. When short-term interest rates, defined in this case as three-month treasury bills, are higher than long-term interest rates, defined as ten-year government bonds, this indicates an inversion of the yield curve. This typically means that the bond market is anticipating a rise in interest rates which will act to slowdown the economic engine, which could lead to a recession and thus a market correction. To avoid this correction, a single change to the asset allocation is conducted as soon as the rates become inverted. After a six-month period, should the rates remain inverted, a second allocation change is conducted.

if( 90-day T-Bills Interest Rate - * > 10-year Bond Interest Rate ) then trigger Sell 2

The * value is used to determine a spread. Although the yield curve becomes inverted once it reaches 0, this study will test spreads of .25 and -.25 to determine whether returns are improved by waiting for a significant spread in the yield curve (-.25), prior to it reaching the inversion point (.25), or as soon as it reaches the inversion point (0). The change to the asset allocation occurs when one or both signals are triggered. The specifics of the changes will be discussed in the next section of this document.

### 2.1.2 Asset allocation change

The previously defined triggers set off a change to the asset allocation. These changes can be defined as follows:

Table 1. Asset allocation changes from buy signals.

| Trigger | Equity allocation change | Bond allocation change |
|---|---|---|
| Buy 1 - S&P500TR Trend Only | +50% Equity | -50% Bonds |
| Buy 2 - S&P500TR Volatility Only | +50% Equity | -50% Bonds |
| Buy 1 & Buy 2 | +50% Equity | -50% Bonds |

Table 2. Asset allocation changes from sell signals.

| Trigger | Equity allocation change | Bond allocation change |
|---|---|---|
| Sell 1 - S&P500TR Trend Only | -50% Equity | +50% Bonds |
| Sell 2 - Inversion of the yield curve | -50% Equity | +50% Bonds |
| Sell 1 & Sell 2 | -50% Equity | +50% Bonds |

In this manner, the asset allocation is modified at irregular intervals based on the four triggers by the amounts defined above. The 50% allocation change was selected as it is meant to trigger large sudden changes in the asset allocation in an effort to avoid corrections and take part in bull markets. To avoid complete changes in

the asset allocation, when both signals are triggered in one month, only a 50% change in the asset allocation is completed.

To further test the effects of the allocation percentages, 25%, 50%, 75% and 100% changes to the asset allocation will be compared to determine their impacts.

## 2.2 Analysis and Results

To determine the success of the various indicators in comparison to the buy-and-hold strategy of both indexes, the extensive list of results will be showcased. The thirty-year numbers represent an investment of $100 compounding tax-free from January 1st, 1980 and ending December 31st, 2009, in either the S&P500 Total Return Index, the Barclay's Capital Market Aggregate Index or a $100 investment employing the tactical asset allocation strategy defined in section 2.1.1.

Table 3. Summary of TAA Strategy Returns & σ

The following table shows the results of the portfolio strategy based on past returns from January 1st, 1980 and ending December 31st, 2009. The first column is used to number every individual examination. The second column defines the geometric value set for the first trigger. A 0.8 value means that any time throughout the last thirty years that the geometric returns of the most three month period were to drop below 20%, then the trigger was set off and an asset allocation change was effectuated (+50% equity, -50% bonds). .85 equates a 15% loss while .9 would be triggered in the event of a 10% geometric loss in the last three months. The third column is used to quantify the second buy signal, the standard deviation of returns. Whenever one of the last three month's standard deviation of the S&P 500TR was either 2 times, 2.25 times or 2.5 times higher than the average monthly standard deviation of the S&P500TR over the last 30 years, Buy Trigger 2 was set off and a change to asset allocation (+50% equity, -50% bonds) would have influenced the final outcome of the strategy. Similarly, the fourth column triggers changes to the asset allocation whenever a specific number of months in the past year have had positive returns. If 9, 10 or 11 of the last twelve months have had positive returns, then a change to the asset allocation would have been done (-50% equity, +50% bonds) and the results aggregated. The fifth column is used to determine the values of the second sell trigger, the spread in the yield curve. Whenever the spread between short-term bonds and long-term bonds crosses either 0.25, 0 or -0.25 for the first time in the last twelve months, there would be a change to the asset allocation (-50% equity, +50% bonds) over the thirty year period. As there were four variables tested with three different values, we ended with a total of 81 ($3^4$) examinations.

| | Buy 1 geometric loss > | Buy 2 σ of monthly return > | Sell 1 # of + months in a year > | Sell 2 Spread in the yield curve < | TAA Strategy Returns (Growth of 100) | Std Dev. (Average σ of monthly returns) | | Buy 1 geometric loss > * | Buy 2 σ of monthly return > | Sell 1 # of + months in a year > | Sell 2 Spread in the yield curve < | TAA Strategy Returns (Growth of 100) | Std Dev. (Average σ of monthly returns) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 2 | 9 | 0 | 1680.22 | 3.41% | 42 | 0.85 | 2.5 | 10 | -0.25 | 3266.59 | 2.96% |
| 2 | 0.8 | 2.25 | 9 | 0 | 2626.25 | 2.82% | 43 | 0.9 | 2 | 10 | -0.25 | 1649.76 | 3.75% |
| 3 | 0.8 | 2.5 | 9 | 0 | 2336.38 | 2.81% | 44 | 0.9 | 2.25 | 10 | -0.25 | 2072.14 | 3.57% |
| 4 | 0.85 | 2 | 9 | 0 | 1680.22 | 3.41% | 45 | 0.9 | 2.5 | 10 | -0.25 | 2103.61 | 3.57% |
| 5 | 0.85 | 2.25 | 9 | 0 | 3143.25 | 2.91% | 46 | 0.8 | 2 | 10 | 0 | 2123.68 | 3.66% |
| 6 | 0.85 | 2.5 | 9 | 0 | 3243.21 | 2.91% | 47 | 0.8 | 2.25 | 10 | 0 | 3379.61 | 3.11% |
| 7 | 0.9 | 2 | 9 | 0 | 1466.17 | 3.75% | 48 | 0.8 | 2.5 | 10 | 0 | 3002.03 | 3.10% |
| 8 | 0.9 | 2.25 | 9 | 0 | 1759.80 | 3.64% | 49 | 0.85 | 2 | 10 | 0 | 2123.68 | 3.66% |
| 9 | 0.9 | 2.5 | 9 | 0 | 1815.76 | 3.65% | 50 | 0.85 | 2.25 | 10 | 0 | 4044.92 | 3.19% |
| 10 | 0.8 | 2 | 9 | 0.25 | 1876.00 | 3.65% | 51 | 0.85 | 2.5 | 10 | 0 | 4173.55 | 3.19% |
| 11 | 0.8 | 2.25 | 9 | 0.25 | 2796.59 | 2.78% | 52 | 0.9 | 2 | 10 | 0 | 1732.58 | 3.87% |
| 12 | 0.8 | 2.5 | 9 | 0.25 | 2487.93 | 2.77% | 53 | 0.9 | 2.25 | 10 | 0 | 2079.57 | 3.76% |
| 13 | 0.85 | 2 | 9 | 0.25 | 1876.00 | 3.65% | 54 | 0.9 | 2.5 | 10 | 0 | 2145.71 | 3.77% |
| 14 | 0.85 | 2.25 | 9 | 0.25 | 3347.13 | 2.87% | 55 | 0.8 | 2 | 11 | 0.25 | 3225.89 | 4.23% |
| 15 | 0.85 | 2.5 | 9 | 0.25 | 3453.57 | 2.87% | 56 | 0.8 | 2.25 | 11 | 0.25 | 4346.97 | 3.89% |
| 16 | 0.9 | 2 | 9 | 0.25 | 1396.49 | 3.82% | 57 | 0.8 | 2.5 | 11 | 0.25 | 4254.78 | 3.56% |
| 17 | 0.9 | 2.25 | 9 | 0.25 | 1873.95 | 3.61% | 58 | 0.85 | 2 | 11 | 0.25 | 3225.89 | 4.23% |
| 18 | 0.9 | 2.5 | 9 | 0.25 | 1933.54 | 3.62% | 59 | 0.85 | 2.25 | 11 | 0.25 | 4346.97 | 3.89% |
| 19 | 0.8 | 2 | 9 | -0.25 | 1896.16 | 3.11% | 60 | 0.85 | 2.5 | 11 | 0.25 | 4485.21 | 3.89% |
| 20 | 0.8 | 2.25 | 9 | -0.25 | 1958.63 | 2.54% | 61 | 0.9 | 2 | 11 | 0.25 | 2597.80 | 4.34% |
| 21 | 0.8 | 2.5 | 9 | -0.25 | 1714.40 | 2.53% | 62 | 0.9 | 2.25 | 11 | 0.25 | 2675.27 | 4.29% |
| 22 | 0.85 | 2 | 9 | -0.25 | 1896.16 | 3.11% | 63 | 0.9 | 2.5 | 11 | 0.25 | 2760.35 | 4.29% |
| 23 | 0.85 | 2.25 | 9 | -0.25 | 2344.20 | 2.64% | 64 | 0.8 | 2 | 11 | -0.25 | 4605.15 | 3.83% |
| 24 | 0.85 | 2.5 | 9 | -0.25 | 2379.81 | 2.64% | 65 | 0.8 | 2.25 | 11 | -0.25 | 4913.41 | 3.36% |
| 25 | 0.9 | 2 | 9 | -0.25 | 1371.20 | 3.64% | 66 | 0.8 | 2.5 | 11 | -0.25 | 4136.14 | 3.36% |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 0.9 | 2.25 | 9 | -0.25 | 1722.26 | 3.44% | 67 | 0.85 | 2 | 11 | -0.25 | 4605.15 | 3.83% |
| 27 | 0.9 | 2.5 | 9 | -0.25 | 1748.41 | 3.45% | 68 | 0.85 | 2.25 | 11 | -0.25 | 5880.66 | 3.43% |
| 28 | 0.8 | 2 | 10 | 0.25 | 2273.84 | 3.77% | **69** | **0.85** | **2.5** | **11** | **-0.25** | **5969.98** | **3.44%** |
| 29 | 0.8 | 2.25 | 10 | 0.25 | 3598.83 | 3.07% | 70 | 0.9 | 2 | 11 | -0.25 | 2854.82 | 4.19% |
| 30 | 0.8 | 2.5 | 10 | 0.25 | 3196.75 | 3.06% | 71 | 0.9 | 2.25 | 11 | -0.25 | 3244.90 | 4.07% |
| 31 | 0.85 | 2 | 10 | 0.25 | 2273.84 | 3.77% | 72 | 0.9 | 2.5 | 11 | -0.25 | 3294.19 | 4.07% |
| 32 | 0.85 | 2.25 | 10 | 0.25 | 4307.29 | 3.15% | 73 | 0.8 | 2 | 11 | 0 | 3630.79 | 4.03% |
| 33 | 0.85 | 2.5 | 10 | 0.25 | 4444.27 | 3.15% | 74 | 0.8 | 2.25 | 11 | 0 | 4691.56 | 3.70% |
| 34 | 0.9 | 2 | 10 | 0.25 | 1692.65 | 3.93% | 75 | 0.8 | 2.5 | 11 | 0 | 3895.52 | 3.60% |
| 35 | 0.9 | 2.25 | 10 | 0.25 | 2271.36 | 3.73% | 76 | 0.85 | 2 | 11 | 0 | 3630.79 | 4.03% |
| 36 | 0.9 | 2.5 | 10 | 0.25 | 2343.59 | 3.74% | 77 | 0.85 | 2.25 | 11 | 0 | 5615.14 | 3.77% |
| 37 | 0.8 | 2 | 10 | -0.25 | 2440.08 | 3.38% | 78 | 0.85 | 2.5 | 11 | 0 | 5793.70 | 3.77% |
| 38 | 0.8 | 2.25 | 10 | -0.25 | 2688.46 | 2.87% | 79 | 0.9 | 2 | 11 | 0 | 2962.15 | 4.23% |
| 39 | 0.8 | 2.5 | 10 | -0.25 | 2349.65 | 2.86% | 80 | 0.9 | 2.25 | 11 | 0 | 2965.20 | 4.19% |
| 40 | 0.85 | 2 | 10 | -0.25 | 2440.08 | 3.38% | 81 | 0.9 | 2.5 | 11 | 0 | 3059.50 | 4.19% |
| 41 | 0.85 | 2.25 | 10 | -0.25 | 3217.71 | 2.96% | | | | | | | |

The study reveals that the combination of indicators that when triggered produced the most significant returns were:

- Buy Signal 1: Geometric loss of more than 15%
- Buy Signal 2: σ of monthly return 2.5 times greater than the average over 30 years
- Sell Signal 1: More than 11 months positive in the last twelve months
- Sell Signal 2: A yield curve spread of -0.25

The results indicate that amongst these indicators, the inversion of the yield curve at -0.25 along with the number of positive months above 11 were the two most significant influencing factors on returns.

In an effort to understand the impacts of the asset allocation change percentages, a secondary study was conducted to verify the changes that increasing and decreasing the percentage modifications to the asset allocation throughout the thirty-year examination period would have on returns and standard deviation. Drawing from the most successful signal scheme (.85, 2.5, 11, -0.25), new percentage changes were tested. In other words, whenever the signals would determine it appropriate for a change to the asset allocation, a different set of returns was tested instead of the 50%, 50% change as discussed in section 2.1.2.

Table 4. Asset allocation change results

The following table showcases the results of the TAA strategy when a variety of asset allocation changes are applied. Whenever an indicator is triggered, a change to the asset allocation is triggered. In Table 3, a 50% change was effectuated for both buy and sell triggers. This table shows the results of modifying the % of assets changed when the various indicators are triggered. For example, Row 1 shows a change of 25% to the asset allocation when a Buy signal is triggered, meaning that should this occur, equity weightings would be raised by 25% while bond weightings would be reduced by 25%. Similarly, should a sell signal be triggered, equities would be reduced by 25% while bond weightings would be increased by 25%. The impact on returns of varying the percentage change of the weightings is examined in the following table.

| | Buy Trigger Asset allocation % change | Sell Trigger Asset allocation % change | TAA Strategy Returns (Growth of 100) | Std Dev. (Average σ of monthly returns) | | Buy Trigger Asset allocation % change | Sell Trigger Asset allocation % change | TAA Strategy Returns (Growth of 100) | Std Dev. (Average σ of monthly returns) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 25% | -25% | 4168.57 | 3.22% | 9 | 75% | -25% | 4548.68 | 3.81% |
| 2 | 25% | -50% | 3566.49 | 2.66% | 10 | 75% | -50% | 6333.47 | 3.55% |
| 3 | 25% | -75% | 2558.82 | 2.40% | 11 | 75% | -75% | 6442.93 | 3.49% |
| 4 | 25% | -100% | 2217.63 | 2.27% | 12 | 75% | -100% | 4846.30 | 3.18% |
| 5 | 50% | -25% | 4728.25 | 3.73% | 13 | 100% | -25% | 4747.02 | 3.85% |
| 6 | 50% | -50% | 5969.98 | 3.44% | 14 | 100% | -50% | 6673.67 | 3.71% |
| 7 | 50% | -75% | 4666.74 | 3.08% | 15 | 100% | -75% | 6789.97 | 3.65% |
| 8 | 50% | -100% | 4666.74 | 3.08% | 16 | 100% | -100% | 6878.55 | 3.63% |

The findings indicate that when a buy and sell indicator is triggered, a complete 100% change to the asset allocation will lead to the highest returns over our given time period using the (.85, 2.5, 11, -0.25) signal scheme. This lends itself well to supporting the accuracy of the selected indicators.

Let us compare these to the returns of a buy-and-hold investment strategy in both the S&P500 Total Return Index and the Barclay's Capital Market Aggregate Bond Index.

Table 5. Investment Strategy results compared to Buy-and-Hold of Indexes
Rows 1, 4 & 7 show the final value of $100 invested into the respective indexes, gross of fees and taxes
Rows 2, 5 & 8 show the % annual return of each respective investment
Rows 3, 6 & 9 show the average monthly standard deviation of the investment during its respective time horizon
Rows 1, 2 & 3: January 1st, 1980 to December 30th, 2009
Rows 4, 5 & 6: January 1st, 1990 to December 30th, 2009
Rows 7, 8 & 9: January 1st, 2000 to December 30th, 2009
S&P500 TR: Standard & Poor's 500 Total Return Index
Barclay's Aggregate: Barclay's Capital Aggregate Bond Index
TAA Strategy (50/50) Highest Return: Investment strategy as outlined in section 2.1.1 using 50% changes to the asset allocation with indicators set to (0.85, 2.5, 11, -0.25)
TAA Strategy (50/50) Average: Average result of the 81 observations listed in Table 3
TAA Strategy (100/100): Highest Return: Investment strategy as outlined in section 2.1.1 using 100% changes to the asset allocation with indicators set to (0.85, 2.5, 11,0.25)
TAA Strategy (100/100) Average: Average result of the 81 observations listed in Table 5

| | S&P500 TR | Barclay's Aggregate | TAA Strategy (50/50) Highest Returns | TAA Strategy (50/50) Averages |
|---|---|---|---|---|
| 30 Year – $100 Investment | $2440.11 | $1251.29 | $5969.98 | $2949.72 |
| 30 Year % Annual Return | 11.24% | 8.79% | 14.60% | 11.94% |
| 30 Year Average Monthly σ | 4.48% | 1.69% | 3.44% | 3.50% |
| 20 Year – $100 Investment | $484.30 | $387.80 | $1312.80 | $612.89 |
| 20 Year % Annual Return | 8.21% | 7.01% | 13.74% | 9.49% |
| 20 Year Average Monthly σ | 4.34% | 1.12% | 2.98% | 3.06% |
| 10 Year – $100 Investment | $90.90 | $184.75 | $245.17 | $170.29 |
| 10 Year % Annual Return | -0.95% | 6.33% | 9.38% | 5.47% |
| 10 Year Average Monthly σ | 4.66% | 1.11% | 2.39% | 3.09% |

As it is evidenced in Table 5, under these highly specific conditions attained with the benefit of foresight, the tactical asset allocation strategy as defined has considerably outperformed both indexes. Furthermore, it did so while lowering the average monthly standard deviation when compared to the S&P500 Total Return Index.

This serves as support that with a high-level of accuracy, a TAA strategy can outperform with less variance of returns, and thus should be adopted by all reasonable investors. That being said, these results were computed with the benefit of foresight on past data and as such are not indicative of future results. To better assess the effectiveness of TAA strategies, let us examine the success rate of the other 81 result sets over the thirty year period.

Table 6. Returns and Standard Deviation of Strategy versus S&P500 TR
Source: Table 3 , Table 5.

| | 50% / 50% Allocation Changes | 100% / 100% Allocation Changes |
|---|---|---|
| Number of Observations | 81 | 81 |
| Number of observations that Outperformed S&P500 TR | 45 | 52 |
| Number of observations that Underperformed S&P500 TR | 36 | 29 |

| | | |
|---|---|---|
| % of observations that Outperformed | 56% | 64% |
| Average value of $100 invested for 30 years across the 81 observations | 2949.72 | 3349.06 |
| Number of observations that lowered σ when compared to the S&P500 TR | 81 | 81 |
| Number of observations that increased σ when compared to the S&P500 TR | 0 | 0 |
| % of observations that lowered σ | 100% | 100% |
| Average monthly σ for 30 years across the 81 observations | 3.50% | 3.75% |

Table 6 highlights that although outperformance of the index is possible, it should not be the most important motivator for following a tactical asset allocation strategy. Rather, it is more important to note that the standard deviation of the investment has been lowered in all cases, and thus can provide the investor with an improved risk/reward relationship with only a modest level of success.

To better highlight the differences in risk adjusted rates of return, the Sharpe ratio will be calculated on the 30 year portfolios. The Sharpe ratio is measure of the risk premium, or excess return earned per unit of risk as defined by standard deviation. The risk-free rate was determined by using the average yield on the 90-day T-Bills over the same time period. Table 8 showcases the findings.

**Table 7. Sharpe ratios**

Risk-free rate ($R_f$) was calculated using the average yield of the 90-day T-Bill rate over the same time period
S&P500 TR: Standard & Poor's 500 Total Return Index
Barclay's Aggregate: Barclay's Capital Aggregate Bond Index
TAA Strategy (50/50) Highest Return: Investment strategy as outlined in section 2.1.1 using 50% changes to the asset allocation with indicators set to (0.85, 2.5, 11, -0.25)
TAA Strategy (50/50) Average: Average result of the 81 observations listed in Table 3
TAA Strategy (100/100): Highest Return: Investment strategy as outlined in section 2.1.1 using 100% changes to the asset allocation with indicators set to (0.85, 2.5, 11,0.25)
TAA Strategy (100/100) Average: Average result of the 81 observations listed in Table 5

| | Risk-free Rate | S&P500 TR Sharpe Ratio | Barclay's Aggregate Sharpe Ratio | TAA Strategy (50/50) Highest Returns Sharpe Ratio | TAA Strategy (50/50) Averages Sharpe Ratio | TAA Strategy (100/100) Highest Returns Sharpe Ratio | TAA Strategy (100/100) Averages Sharpe Ratio |
|---|---|---|---|---|---|---|---|
| 30 Year | 5.445% | 1.291 | 1.973 | 2.658 | 1.853 | 2.739 | 1.857 |
| 20 Year | 3.772% | 1.022 | 2.891 | 3.345 | 1.868 | 3.030 | 1.817 |
| 10 Year | 2.693% | -0.782 | 3.276 | 2.798 | 0.899 | 2.614 | 0.735 |
| Average | 3.973% | 0.511 | 2.713 | 2.934 | 1.540 | 2.795 | 1.470 |

Table 8 shows the significant difference in risk-adjusted returns for the TAA strategies when compared to the Buy-And-Hold strategy of the S&P500 Total Return index. We can clearly see that the TAA strategy produced higher Sharpe ratios over all time periods than the S&P500 TR, while the Barclay's Aggregate surpassed the average TAA strategy due to its relatively low standard deviation.

The results produced by this study show that a higher risk-adjusted rate of return can be obtained using a tactical asset allocation even with moderately successful indicators over a variety of time periods.

## 3. CONCLUSION

This study attempts to further the knowledge of tactical asset allocation strategies with the use of economic indicators as market timing signals. Specifically, the examination of an investment strategy using the S&P500 Total Return index and Barclay's Capital Aggregate Bond index strategically weighed based on four distinct buy and sell indicators ranging from market movement data to the spread in the yield curve.

The results indicate that although the potential to considerably outperform a buy-and-hold strategy using the S&P500 TR index is possible, the largest benefit stems from the lowered monthly standard deviation that accompanies the results. The potential for increased returns combined with a lowered variance of returns provide the investor with an increased risk-to-reward relationship, which should thus be adopted by rational investors.

The study also revealed that an investment strategy using the magnitude of monthly variance as an indicator for potential buying opportunities is best served by triggering asset allocation changes when the monthly standard deviation of its tracking index is 2.5 times greater than its historic average standard deviation, when compared to 2.25 and 2 times greater over the thirty year test period.

To a lesser extent, the use of the number of positive months in a calendar year can lead to increased returns when used as an indicator to reduce exposure to equity markets in the coming months. In our observation period, when an asset allocation change was effectuated when eleven of the last twelve months were positive, the results were more attractive than that of nine or ten months in a year.

The inversion of the yield curve as a predictor of oncoming corrections is also well supported by the results generated by this study. Similarly, when an increase to equity markets was initiated following a three-month period where geometric losses were greater than 15%, returns were increased over a 10% or 20% loss scenario.

A secondary study revealed that when accurate indicators are revealed, increasing the percentage change to the asset allocation was favourable to improving results and lowering standard deviation. In fact, the best risk to reward relationship on our test case revealed that a full asset allocation change of 100% was best.

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