Extending a Quantitative Approach to Tactical Asset Allocation in South Africa

INSEAD Masters in Finance (MFIN17M) – Capstone Project

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April 2017

ABSTRACT

In this paper I replicate and update Mebane Faber’s “A Quantitative Approach to Tactical Asset Allocation” with new data from 2013-2016 before analysing the latest performance and identifying behavioural implications for investors following the strategy. I then look at trading strategies that aim to improve the timing model’s performance before applying the original strategy and alternative strategies to an asset allocation more relevant for an investor in South Africa.

Overall I find

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# Introduction

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* Pose questions / what trying to solve
* Clear and concise

In 2006 Mebane Faber released a series of papers titled a quantitative approach to tactical asset allocation which have since become the most downloaded and read papers on SSRN.

The paper introduced a timing strategy for asset allocation that resulted

This paper looks to extend Faber’s research by first replicating the original results and updating with the inclusion of the last 4 years or price history. After analysing the results, the paper identifies practical and behavioural issues for investors trading this strategy. Keeping these in mind, the paper then tests ideas to improve the timing model and analyses the resutls

Lastly this paper then applies the original and improved timing model

# Replication of A Quantitative Approach to Tactical Asset Allocation

## Summary of A Quantitative Approach to Tactical Asset Allocation

In July 2006, Mebane Faber began to circulate a working paper entitled A Quantitative Approach to Tactical Asset Allocation which was subsequently published by The Journal of Wealth Management in Spring 2007. In February 2009 Faber updated his paper to include data from 2006-2008 and then again updated the paper in February 2013 to include data from 2009-2012 as well as test the approach on alternative asset classes and allocations.

The purpose of the paper was “to present a simple quantitative method that improves risk adjusted returns across various asset classes” (Faber, A Quantitative Approach to Tactical Asset Allocation, 2013). Testing over five asset classes from 1973-2012, his approach improved risk adjusted returns in every asset class tested and when applied to asset allocation, resulted in a portfolio that exhibited equity like returns with bond like volatility and drawdowns.

The quantitative approach proposed by Faber market times entries and exits into positions using a common trend following simple moving average based system. The entry and exit rules were simple; buy when the price was greater than the simple moving average and sell and move to cash when the price crossed below the simple moving average. Using monthly data, Faber chose the 10 month averaging period for his system however showed parameter stability of using various moving average periods ranging from 3 to 12 months. Overall this system met his criteria of being “simple enough for investors to follow, and mechanical enough to remove emotion and subjective decision-making” (Faber, A Quantitative Approach to Tactical Asset Allocation, 2013).

Applying the timing system to to individual asset classes consistently resulted in improved absolute returns, risk adjusted returns and max drawdowns. On average between 1973-2008 the timing system “increased returns by approximately 20%, decreased volatility by 20%, improved the Sharpe Ratio by 0.20 and reduced the maximum drawdown by nearly 50%” (Faber, A Quantitative Approach To Tactical Asset Allocation, 2009).

The timing system was then applied to an asset allocation that was equal weighted five asset classes. Comparing to a buy and hold portfolio, the timing system improved various performance and risk metrics. Between 1973-2012, the timing system produced better returns of 10.48% (vs 9.92% for the buy and hold) and lower volatility of 6.99% (vs 10.28%) resulting in an improved Sharpe ratio of 0.73 (vs 0.43). Critically for drawdown adverse investors, the maximum drawdown of the timing system model was only -9.54% (vs -46.00%) meaning that investors in the strategy never experienced the pain of giving back more than 10% despite multiple financial crashes. Remarkably in the 40 years of data between 1973-2012, the timing strategy only had 1 year of negative performance which was a very reasonable -0.59%.

## Data used

Faber applied his quantitative approach to five asset classes – Domestic (US Large Cap) Equities, Foreign Developed Equities, US Bonds, Commodities and Real Estate. He chose publicly traded indices representing these asset classes and obtained monthly total return data series from Global Financial Data to use in his framework. The actual indices chosen were Standard and Poor’s 500 Index (S&P 500), Morgan Stanley Capital International Developed Markets Index (MSCI EAFE), United States Government 10yr Treasure Bonds (US10YR), Goldman Sachs Commodity Index (GSCI) and the National Association of Real Estate Investment Trusts Index (NAREIT).

Global Financial Data is a paid data provider unwilling to make their data available for academic purposes and alternative data used in this paper has been obtained from a variety of sources. S&P500, NAREIT, EAFE, GSCI total return index data were available on Bloomberg. To represent Fixed Income, 10-year US Government Bond Yields were obtained from the Federal Reserve Economic Data (FRED) database maintained by the Federal Reserve Bank of St. Louis and a total return index that takes into consideration both capital appreciation and income return has been created following a methodology paper from Morningstar (Return Calculation of U.S. Treasury Constant Maturity Indices, 2008). A similar index to represent risk free returns was created using 3-month US Treasury Bill yields. Replicate Faber’s results between 1973-2012 using this data resulted in minimal differences giving confidence that the alternative dataset is close enough to the original GFD data that it can be used and its results are representative.

Table 1 - Data Sources

|  |  |
| --- | --- |
| **Asset Class** | **Source** |
| Domestic Equities | 1972-2016: S&P 500 Total Return Index (Bloomberg - SPTR2 Index) |
| Foreign Equities | 1972-2016: MSCI EAFE Total Return Index (Bloomberg - GDDUEAFE Index) |
| Fixed Income | 1972-2016: Total return index created using 10-Year Treasury Constant Maturity Rates (FRED – DGS10) |
| Commodities | 1972-2016: S&P GSCI Total Return Index (Bloomberg - SPGSCITR Index) |
| Property | 1972-2016: FTSE NAREIT Composite Real Estate Total Return Index (Bloomberg - FNCOTR Index) |
| Inflation | 1972-2016: U.S. Bureau of Labor Statistics Consumer Price Index for All Urban Consumers: All Items (FRED – CPIAUCSL) |
| Risk Free | 1972-2016: Risk free / Cash index created using 3-Month Treasury Bill: Secondary Market Rates (FRED – DTB3) |

## Strategy Performance Metrics

A trading strategy’s performance is commonly analysed and judged by inspecting its returns that have been somewhat adjusted for risk. Simply looking at the return would be unfair (Ilmanen, 2011) as it ignores the volatility of the strategy and whether it is something that can realistically be handled by the investor (Clenow A. , 2013). In Faber’s papers, he compares strategies by looking at the Compounded Annual Growth Rate (CAGR), Volatility, Sharpe Ratio, Max Drawdown and in some comparisons, he also includes the percentage of positive months as well as the growth of $100. Although the basic structure of all composite risk measures are the same, it is recommended that several better understood metrics are selected to give a fuller understanding of each strategy’s performance and risk (Bacon, 2004). In this paper the following metrics have been included to analyse performance:

Table 2 - Performance Metrics

|  |  |  |
| --- | --- | --- |
| CAGR | % in the Market | Max Drawdown / CAGR |
| Volatility | % Positive Months | Sharpe Ratio |
| Skew | Best Month | Sortino Ratio |
| Kurtosis | Worst Month | MAR Ratio |
| Inflation CAGR | Max Drawdown | Ulcer Index |

Different performance metrics provide alternative descriptive ways of viewing the performance of each strategy. The Sharpe Ratio is one of the most commonly used and cited measures to compare strategies of different volatility and was the only risk adjusted return metric included in Faber’s papers. Originally developed by William Sharpe in 1966, the formula is simply the annualised return less the risk free return divided by the volatility of the return. One of the problems with the Sharpe Ratio is that is penalises all volatility whereas in some cases, such as when the strategy is making money on the upside, the investor may actually like and desire volatility. With this in mind the Sortino Ratio has been included as it only adjusts using the volatility of negative returns and does not punish returns for moves in the right direction.

Volatility is one measure used by investors who are risk adverse but it is well known that investors can also be loss adverse. As such measures that risk adjust returns by the maximum drawdown have also been included such as the MAR ratio (or Calmar ratio). It is traditional to use 3 years for the Calmar ratio, however here the MAR ratio is used which looks at the whole time period. Max Drawdown / CAGR is a very similar metric that has also been included purely for its simplicity to illustrate to investors the magnitude of drawdowns as the time period required to recover based on average annual returns. Developed by Peter Martin in 1987 the Ulcer Index has also been included as another measure of downside risk. Suited for long only strategies, the ulcer index focuses on the length and severity of drawdowns and the worry caused to the investor – the higher a strategy’s Ulcer Index, the more likely it will cause sleepless nights or ulcers for the investor (Martin & McCann, 1989).

Lastly skew and kurtosis have been included to give a more complete understanding of the return distribution. Strategies, such as those that sell out of the money put options, can have very consistent stable returns with very respectable Sharpe Ratios resulting in overconfidence in the risk of the strategy. However when markets move against them they are susceptible to rare but very large losses which can be identified with negative skewed fat kurtosis distributions.

## Asset Returns 1973-2016

Reviewing the performance of each asset class between 1973-2016 shows multi decade positive absolute returns for all classes. Faber (A Quantitative Approach to Tactical Asset Allocation, 2013) charts asset class returns to see the routes they travelled from start to finish and visually comparing these charts to the replication in Figure 1 supports earlier conclusions that the data used in this paper closely matches the original data provided by Global Financial Data.

Figure 1 - Asset Class Returns 1973-2016, Log Scale

Charting the performance of the most recent years since Faber’s last update in 2013, we can see how assets have performed since 2012. Most assets have continued to deliver positive returns over the period however commodities have significantly underperformed and continued to stay in drawdown since it reached all time highs in 2008.

Figure 2 - Asset Class Returns 2013-2016, Non-Log Scale

Calculating the same performance statistics over these asset classes results in very similar results to Faber’s research, another confirmation that the data used in both pieces of research is close to identical and accurate enough for further extensions.

Table 3 - Asset Class Returns 1973-2012

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | TBILLS | SP500 | EAFE | US10YR | GSCI | NAREIT |
| Return | 5.42% | 9.77% | 9.19% | 8.12% | 8.34% | 9.64% |
| Volatility | 0.95% | 15.71% | 17.60% | 8.47% | 20.55% | 18.16% |
| Sharpe (5.42%) | 0.00 | 0.26 | 0.20 | 0.30 | 0.13 | 0.22 |
| MaxDD | 0.00% | -50.95% | -56.40% | -15.75% | -67.65% | -68.18% |
| Inflation CAGR | 4.33% | 4.33% | 4.33% | 4.33% | 4.33% | 4.33% |

Extending these performance statistics to include 2013-2016, the biggest change in performance for any asset class is as expected in commodities. From extending 40 years of data to include another 4 years, the current drawdown in commodities has resulted in a 30% reduction of the CAGR from 8.34% to 5.85%. The depth of the most recent drawdown was captured at 80.90% agreeing with Faber observation and warning that asset classes have in the past and are likely to have period where they decline 50-100%. Another interesting impact of the most recent data was its effect on SP500 performance. The current strong performance of the index to test all time highs has results in a 0.40% increase in CAGR with a similar sized reduction in volatility, resulted in its Sharpe Ratio increasing 27% from 0.26 to 0.33.

Table 4 - Asset Class Returns 1973-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | TBILLS | SP500 | EAFE | US10YR | GSCI | NAREIT |
| Return | 4.93% | 10.18% | 8.75% | 7.41% | 5.85% | 9.65% |
| Volatility | 1.00% | 15.30% | 17.21% | 8.33% | 20.52% | 17.81% |
| Sharpe (4.93%) | 0.00 | 0.33 | 0.21 | 0.28 | 0.04 | 0.25 |
| MaxDD | 0.00% | -50.95% | -56.40% | -15.75% | -80.90% | -68.18% |
| Inflation CAGR | 4.04% | 4.04% | 4.04% | 4.04% | 4.04% | 4.04% |

Figure 3 - Asset Class returns 1973-2016

## A Global Tactical Asset Allocation 1973-2016

Replicating the timing strategy across all assets within the Global Tactical Asset Allocation model, we see that the percent of time invested including the most recent years has not changed significantly and remained at 70.81%.

Table 5 - Percentage of Time Invested 1973-2016

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Positions | % Invested | # of Months | % of Months |
| 0 (all cash) | 0% | 6 | 1.13% |
| 1 | 20% | 32 | 6.05% |
| 2 | 40% | 62 | 11.72% |
| 3 | 60% | 118 | 22.31% |
| 4 | 80% | 192 | 36.29% |
| 5 | 100% | 119 | 22.50% |
| TOTAL |  | 529 | 100.00% |

Figure 4 - Buy and Hold vs. Timing Model 1973-2016, Log scale

Figure 5 - Buy and Hold vs. Timing Model 1973-2016, Non-log scale

Table 6 - Summary of Returns for Buy and Hold vs Timing Model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 1973-2005 | | 1973-2012 | | 1973-2016 | |
|  | B&H | Timing | B&H | Timing | B&H | Timing |
| CAGR | 11.30% | 11.58% | 9.98% | 10.61% | 9.29% | 9.84% |
| Volatility | 8.98% | 6.93% | 10.27% | 7.01% | 10.09% | 6.87% |
| Skew | -0.45 | -0.48 | -1.09 | -0.54 | -1.02 | -0.48 |
| Kurtosis | 1.48 | 2.57 | 5.23 | 2.41 | 5.06 | 2.35 |
| Inflation CAGR | 4.77% | 4.77% | 4.33% | 4.33% | 4.04% | 4.04% |
| % in the Market | 100.00% | 72.29% | 100.00% | 71.23% | 100.00% | 70.81% |
| % positive Months | 67.76% | 73.55% | 66.94% | 72.14% | 65.60% | 70.51% |
| Best Month | 9.10% | 6.58% | 9.22% | 6.58% | 9.22% | 6.58% |
| Worst Month | -9.23% | -9.29% | -19.34% | -9.29% | -19.34% | -9.29% |
| Max Drawdown | -19.61% | -9.56% | -46.10% | -9.56% | -46.10% | -9.56% |
| Max Drawdown / CAGR | 1.74 | 0.83 | 4.62 | 0.90 | 4.96 | 0.97 |
| Sharpe Ratio (4.93%) | 0.52 | 0.72 | 0.42 | 0.70 | 0.41 | 0.68 |
| Sortino Ratio | 0.62 | 0.88 | 0.44 | 0.77 | 0.42 | 0.73 |
| MAR Ratio | 0.58 | 1.21 | 0.22 | 1.11 | 0.20 | 1.03 |
| Ulcer Index | 4.05 | 1.73 | 8.09 | 2.29 | 7.95 | 2.36 |

Reviewing the performance of the asset allocation strategies since Faber first published his research in 2006, it appears the absolute performance and risk adjusted performance has decreased and may be slightly below any expectations set by the original research paper. The CAGR for both the buy and hold strategy and the timing strategy has decreased by approximately 2% whilst volatility has remained fairly constant, or in the buy and hold strategy’s case increased.

Figure 6 - Buy and Hold vs. Timing Model 2006-2016, non-log scale

Figure 7 - Buy and Hold vs. Timing Model Drawdowns, 2006-2016

Figure 8 - Rolling 12-month Annualised Returns 2006-2016

Investors who initiated the timing model in 2006/2007 after the research was first published would likely have been pleased with the initial performance. The timing system removed exposure to the market during the financial crisis of 2007-2008 reducing drawdowns to single figures despite the comparison buy and hold portfolio suffering its greatest drawdown since 1972 of 46.1%. However since then, most asset classes have recovered and between 2010-2016, investors in the timing strategy expecting double figure absolute returns have experienced a CAGR of 2.63%. As major benchmarks such as the S&P and Dow Jones Indices make regular news headlines for reaching new all time highs, it’s easy to imagine investors questioning their choice of strategy over this period.

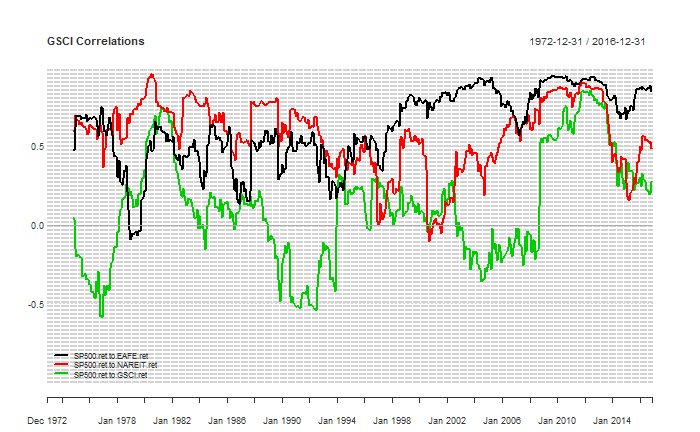
# Analysis of performance

## Diversification and Modern Portfolio Theory

One of the core drivers of the absolute returns of the strategies within Faber’s paper is diversification. “Diversification is often spoken of as the only free lunch in investing” (Jennings & Payne, 2016) and has the ability to enhance returns without necessarily increasing risk. The proverb “don’t put all your eggs in one basket” explains it succinctly; invest in a portfolio of different assets and you’ll always have less (or at most equal) risk to the riskiest asset on its own. The benefits of diversification are well known and have been acknowledged for thousands of years. The bible book of Ecclesiastes, thought to have been written around 900BC, tells the reader to “divide your investments among many places, for you do not know what risks might lie ahead” (Ecclesiastes 11:2). Today some successful hedge fund managers see diversification as “the single most important factor to influence the overall long term results” (Clenow A. , 2013).

In 1952 Dr Harry Markowitz published his seminal paper Portfolio Selection (Portfolio Selection, 1952) introducing practitioners to a mathematical framework that explained the benefits of portfolio diversification. Stating rational investors desired returns and disliked variance, he hypothesised the E-V rule used to create efficient portfolios of diversified securities. Although admitting that diversification could not completely eliminate all variance, he showed investors were able to use the E-V rule to derive an optimal portfolio of assets with either the lowest risk for a given level of expected return or the highest expected return for a given level of risk. Markowitz’s paper notes that although the E-V rule identifies diversification as a driver for more efficient portfolios, it requires the right kind of diversification of a selection of securities with low covariance among themselves. Markowitz’s work contributed to what is known today as Modern Portfolio Theory and eventually won him a Nobel prize in 1990.

Modern Portfolio Theory has several criticisms however. The risk, return and correlation inputs into the model are based on expected values assumed to stay constant over time and returns are assumed to follow a Gaussian/normal distribution. Risk in modern portfolio theory is represented by variance, however its questionable whether rational investors will still dislike variance when an asset is moving in their desired direction. Modern portfolio theory manages risk through diversification however it ignores that during extreme market panic, correlations tend towards one.



[insert chart of correlations between 5 asset classes].

Global financial market crises in the 1987, 1998, 2001 and 2008 have shown that in these times markets tend to behave as one (Sandoval Jr & Franca, 2010). It’s in these periods that diversification does little to reduce drawdowns and where trend following market timing strategies have demonstrated value protecting the returns of a diversified portfolio.

Trend following is conceptually a very basic strategy – when prices start moving in a direction, jump on the trend and follow it. When prices stop trending and begin to move against you, take your profits or cut your losses. The strategy never buys at the very bottom nor sells at the very top but rather focuses on catching the majority of a long extended price move in the middle.

On the surface trend following appears to be similar to momentum strategies and is even used regularly used by professional asset managers when marketing momentum based strategies. However unlike momentum strategies, applying trend following to a single asset class is unlikely to be successful and have poor performance. Trend following requires a diversified set of markets to perform successfully and the fundamental premise of trend following is based on diversification (Clenow A. F., 2015). Individual asset classes will have extended periods of time where the market is range bound and trend following strategies will be unsuccessful. By trading multiple asset classes, it’s likely at least one asset class is trending and the strategy participates in these moves compensating for losses in the range bound markets elsewhere.

Trend following has had plenty of criticism over the years especially from classical economists supporting efficient markets. However, there is plenty of empirical evidence the combined with strong performance numbers, especially during periods of extreme equity markets drawdowns, has seen the use of trend following rapidly grow as an investment strategy over the last 40 years.

Greyserman & Kaminski (2014) analyse the performance of trend following from 1223 to 2013 using a simple trend following strategy over a unique dataset for 84 markets in equity, fixed income, foreign exchange and commodity markets. They find trends exist in market prices due to fundamental, technical and behaviour reasons but ultimately conclude that trend followers don’t care about the underlying reason and just want to ride the trend whenever the opportunity arrives. They find the driver of performance in a trend following strategy to be the ability to cut losses and take profits rather than the entry signal to get into the trend. Michael Covel (Trend Following, 2013) identifies that trend following traders use mechanical trading systems to gain this ability to cut losses and take profits. Mechanical trading systems are based on an objective set of rules and remove discretionary decisions subject to emotion and behavioural biases.

Ultimately trend following timing strategies are risk reduction techniques. They remove exposure to a position during long periods of drawdown without necessarily penalising overall long term returns. A simple mechanical trend following strategy helps to avoid cognitive biases humans exhibit when making trading decisions such as anchoring bias, loss aversion, illusion of control. By managing the downside and overlaying a trend following strategy, returns that are usually negative skewed are converted in positive skewed distributions [insert SA charts comparing buy and hold vs timing returns to show mean/skew/kurtosis]. Faber (A Quantitative Approach to Tactical Asset Allocation, 2007) identifies that most common asset classes experience painful drawdowns with multiple examples of 40-100% drawdowns. Trend following reduces volatility and by being out of markets during these substantial periods of decline, avoids long painful drawdowns for the investor.

Faber’s simple five asset class equal weighted allocation, even on a buy and hold basis, presents evidence of the benefits of diversification. The trend following timing overlay manages risk and results in a reduction of volatility at no expense to returns. Crucially the timing signal reduces portfolio drawdowns to the point that the investor only experience one down year since 1973, with that being a very palatable -1%. Trend following isn’t about achieving superior absolute returns – it’s about avoiding the painful drawdowns which can destroy multiple previous years of gains. This combined with the power of compounding may result in equal or even better absolute returns over the long run, however more importantly consistently provides improved risk adjusted returns.

## Recent Performance and the Financialisation of Commodities

It’s apparent since Faber originally published his first working paper in 2006, performance of the equal weighted 5 asset class buy and hold portfolio hasn’t been as impressive as historical performance. With the global financial crash in 2007-2008, CAGR between 2006-2016 deteriorated to 3.61% compared to the 11.30% seen between 1973-2006. Volatility also increased from 8.98% to 12.74% and perhaps most painfully felt by investors, the buy and hold portfolio had its largest maximum drawdown ever, experiencing a maximum drawdown of -46.1% or more than double compared to the previous periods maximum drawdown of -19.61%. The Sharpe ratio from 1973-2005 of 0.52 dropped to 0.20 in the following 10 years. Did Faber suffer from hindsight bias when he selected the assets for his equal weighted buy and hold portfolio or can this performance deterioration over the last 10 years be explained elsewhere.

Reviewing the individual returns of each asset class between 2006-2016, it’s clear that commodities were the worst performing asset class and were largely responsible for dragging the overall performance of the diversified buy and hold portfolio down. Since 2006, commodities have a CAGR of -8.47%, volatility higher than all other asset classes of 23.33%, as well as a max drawdown of 80.9% in a period where equity and bond returns have continued to show a positive CAGR despite also suffering significant drawdowns in the global crisis of 2008 where they lost over half their value.

Figure 9 - Asset Class Returns 2006-2016

With hindsight if commodities were excluded from the buy and hold portfolio over the last 10 years, absolute returns and risk adjusted metrics would have been considerably better for both the buy and hold strategy and the timing model.

Table 7 - Portfolio returns with and without commodities 2006-2016

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2006-2016 | B&H | Timing | B&H ex GSCI | Timing ex GSCI |
| CAGR | 3.61% | 4.84% | 6.36% | 6.35% |
| Volatility | 12.74% | 6.49% | 12.61% | 6.65% |
| Skew | -1.39 | -0.61 | -1.03 | -0.21 |
| Kurtosis | 5.76 | 1.80 | 4.29 | 0.20 |
| Inflation CAGR | 1.86% | 1.86% | 1.86% | 1.86% |
| % in the Market | 100.00% | 66.32% | 100.00% | 71.05% |
| % positive Months | 59.40% | 61.65% | 61.65% | 63.16% |
| Best Month | 9.22% | 5.00% | 11.75% | 5.40% |
| Worst Month | -19.34% | -6.87% | -17.12% | -5.28% |
| Max Drawdown | -46.10% | -9.22% | -43.39% | -6.84% |
| Max Drawdown / CAGR | 12.76 | 1.91 | 6.83 | 1.08 |
| Sharpe Ratio (4.93%) | 0.20 | 0.57 | 0.41 | 0.79 |
| Sortino Ratio | 0.13 | 0.34 | 0.23 | 0.48 |
| MAR Ratio | 0.08 | 0.52 | 0.15 | 0.93 |
| Ulcer Index | 14.23 | 3.65 | 11.75 | 3.00 |

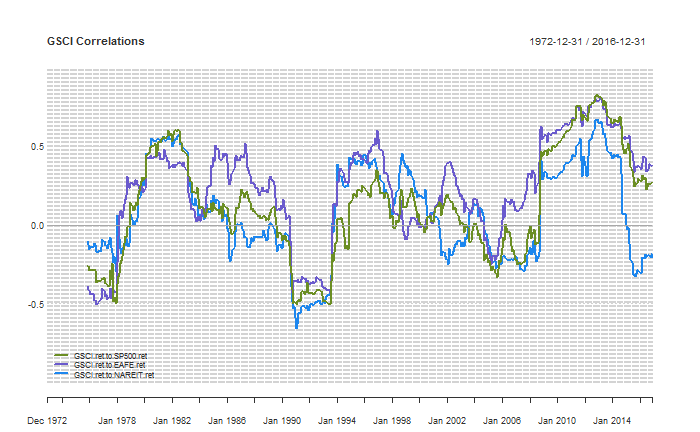
In the 40 year period before 2006, there have multiple other commodity drawdowns and financial crises. Taking the same approach and removing commodities from the portfolio during this time would have resulted in worse performance for an investor in either the buy and hold or timing strategy. The results show the diversifying value of commodities when combined with the other asset classes.

Table 8 - Portfolio returns with and without commodities 1973-2006

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B&H | Timing | B&H ex GSCI | Timing ex GSCI |
| CAGR | 11.30% | 11.58% | 10.73% | 11.15% |
| Volatility | 8.98% | 6.93% | 10.33% | 7.43% |
| Skew | -0.45 | -0.48 | -0.25 | -0.53 |
| Kurtosis | 1.48 | 2.57 | 2.39 | 3.08 |
| Inflation CAGR | 4.77% | 4.77% | 4.77% | 4.77% |
| % in the Market | 100.00% | 22.22% | 100.00% | 23.80% |
| % positive Months | 67.76% | 73.55% | 68.01% | 75.06% |
| Best Month | 9.10% | 6.58% | 15.28% | 8.10% |
| Worst Month | -9.23% | -9.29% | -11.03% | -8.61% |
| Max Drawdown | -19.61% | -9.56% | -34.09% | -9.23% |
| Max Drawdown / CAGR | 1.74 | 0.83 | 3.18 | 0.83 |
| Sharpe Ratio (4.93%) | 0.52 | 0.72 | 0.41 | 0.62 |
| Sortino Ratio | 0.62 | 0.88 | 0.51 | 0.74 |
| MAR Ratio | 0.58 | 1.21 | 0.31 | 1.21 |
| Ulcer Index | 4.05 | 1.73 | 6.55 | 2.25 |

Comparing the two periods it appears that something significant has happened in the most recent period that has resulted in the decline of the diversifying value of commodities to the other asset classes. Reviewing correlations between commodities and SP500, EAFE and NAREIT shows that correlations in 2008 all increased to some of the highest levels they have been historically since 1972 and that they remained at these elevated levels for a much longer period than in the past.

Figure 10 – 36 month Rolling Correlations with GSCI, 1973-2016



A popular topic in research around the time of the release of Faber’s first white paper was the strong diversifying performance of commodities. Two years before Faber released his working version, (Gorton & Rouwenhorst, 2004) released a working paper titled Facts and Fantasies About Commodity Futures highlighting commodities as an ideal diversifier for equity and bond portfolios. They showed that an equal weighted index of commodity futures between 1959 and 2004 produced equity-like returns, slightly lower risk than stocks as measured by standard deviation and less downside risk due to positively skewed returns with relatively high kurtosis. With a negative correlation with both stocks and bonds over most horizons, they concluded commodities as being an especially effective in providing diversification over both stock and bond portfolios.

Following this, in 2006 Ibbotson Associates released a report for PIMCO titled Strategic Asset Allocation and Commodities (Ibbotson Associates, 2006) that analysed the role of commodities within a strategic asset allocation setting. Comparing the returns from 1970 to 2005 of a composite commodity index against US and International stocks, US and International Bonds, Treasury Bills and Inflation, they found that commodities were the top performing asset. During periods of high inflation commodities had the highest arithmetic and compounded returns by a wide margin and in periods of low margin they still returned double digit returns. Ibbotson Associates also identified that commodities had the lowest average correlation to the other asset classes, concluding that including commodities in an asset allocation improved the risk return characteristics of the efficient frontier.

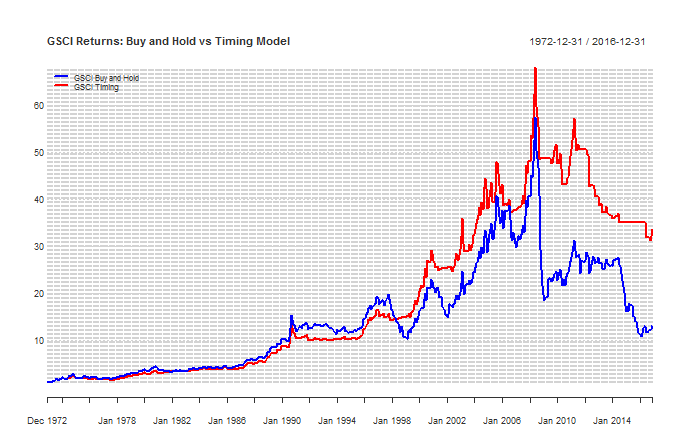
These papers combined with other literature (Erb & Harvey, 2006) drove increased long only investment into commodities financial instruments by investment managers looking to improve risk adjusted portfolio performance. It was reported that there was a significant increase in inflows with hundreds of billions of U.S. dollars flowing into long only commodity investments between 2003-2008 (Bhardwaj, Gorton, & Rouwenhorst, 2015; Irwin & Sanders, 2010). This is thought to have resulted in structural changes in the commodities market later termed financialisation by Domanski and Heath (Financial Investors and Commodity Markets, 2007).

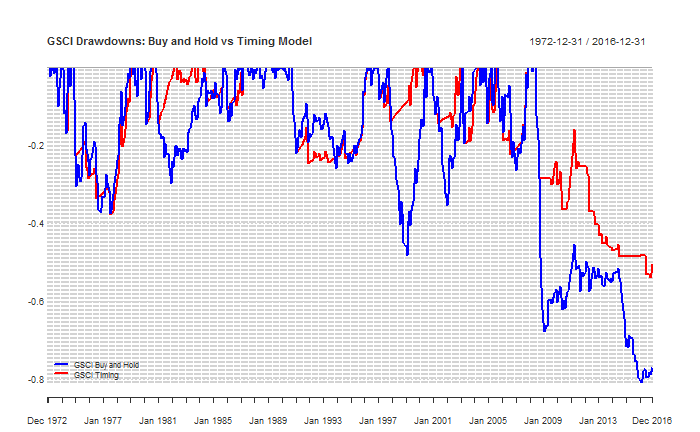
As a result of financialisation, it was thought commodities were no longer driven purely by commodity fundamentals and rather by macroeconomic views of investment managers. Expectations were for increased correlations among commodities and other asset classes. Zaremba (Portfolio Diversification with Commodities in Times of Financialization, 2015) provides one of the more intuitive explanations for this expectation. With an increased number of financial investors holding on to a similar asset allocation of stocks, bonds and commodities, any external shock causing severe capital outflows will necessitate selling of all asset classes in the portfolio at the same time to free up capital, causing correlation to rise. A resulting theme in recent research (Bhardwaj, Gorton, & Rouwenhorst, 2015; Silvennoinen & Thorp, 2009; Cheung & Miu, 2010) reviews financialisation and the recent performance of the commodities sector since financialisation and debate the idea that commodities should no longer be included in a diversified investment portfolio. They conclude that commodities may no longer provide diversifying protection in future times of financial distress similar to the financial crisis of 2008.

Today there are arguments for both including and excluding commodities in an asset allocation. On one hand commodity correlations have returned towards pre 2008 financial crisis levels. There is a wealth of recent research (Bhardwaj, Gorton, & Rouwenhorst, 2015; Levine, Ooi, & Richardson, 2016) showing commodities to have strong returns during periods of growth and high inflation as well as low correlation with stocks and bonds over long horizons, concluding that despite the most recent years of performance and high correlation, commodity futures are still likely to add diversification protection to a portfolio of assets under these regimes in the future.

On the other hand, many (Lombardi & Ravazzolo, 2013; Zaremba, 2015) have argued that the diversification benefits of commodity may not be valid anymore. Due to the structural changes from financialisation resulting in increased correlations during macro market shocks, it has been argued that commodities no longer offer diversification protection for a portfolio with stocks and bonds during financial crisis. Antonacci (Are Commodities Still a Good Portfolio Diversifier?, 2017) also argues that due to the nature of commodity markets changing from financialisation, the papers using data before this period succumb to aggregation bias and will have less forecasting power for the period post financialisation.

Without being able to predict the future and prove which argument is correct, it’s perhaps now a good time to review the performance of the timing model between 2006-2016. Like the buy and hold portfolio, returns were less than expected (4.84% vs 11.58%) however lower volatility resulted in less deterioration of risk adjusted measures such as the Sharpe ratio. Importantly for investors, the max drawdown stayed in line with expectations and was only -9.22% in a period with another financial crisis resulting in the buy and hold experiencing a -46.10% drawdown. Its apparent that the trend following timing strategy can mitigate some of the negative impact of financialisation during crises, removing the investor from commodities during sharp drawdowns. Potentially entering an expected period of rising inflation and growth supports including commodities in the diversified asset allocation. The timing strategy allows the investor to participate in any potential upside under these regimes, whilst likely protecting the investor somewhat in a future financial crisis from deep drawdowns, where it’s not unreasonable to expect correlations to again increase towards one for all asset classes.





## Performance under rising interest rates

It’s well acknowledged that the world has just experienced one of the longest bull markets for fixed income. US Government 10 Year Bond Yields have steadily fallen from highs of 15.84% in 1981 to recent lows of 1.64%. This has resulted in a 35+ year bull market for bond returns.

Figure 11 - US 10 Year Constant Maturity Yields

Figure 12 - US10YR Total Returns, Log Scale

Recently inflammatory news headlines have been common questioning whether trend following strategies can deliver the same performance in a rising rates cycle. Some critics have questioned whether trend following strategies only generate positive risk adjusted returns during periods of falling rates. To analyse potential performance under a rising rates regime, let’s review the period 1973-1981 where it was a clear rising rates environment.

Figure 13 - Asset Class Returns 1973-1981, Non log scale

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | TBILLS | SP500 | EAFE | US10YR | GSCI | NAREIT |
| Return | 8.41% | 5.19% | 7.97% | 3.65% | 12.81% | 6.85% |
| Volatility | 0.89% | 16.56% | 16.96% | 9.27% | 23.53% | 22.15% |
| Sharpe (8.41%) | 0.00 | -0.18 | -0.03 | -0.48 | 0.17 | -0.07 |
| MaxDD | 0.00% | -42.65% | -41.53% | -15.75% | -37.45% | -58.10% |
| Inflation CAGR | 9.23% | 9.23% | 9.23% | 9.23% | 9.23% | 9.23% |

Reviewing the asset class performance over this period its immediately apparent that commodities were the strongest performing asset class. This supports research (Bhardwaj, Gorton, & Rouwenhorst, 2015; Levine, Ooi, & Richardson, 2016) identifying rising inflation as a regime where commodities deliver strong performance. Commodities were the only asset class to beat inflation with all other asset classes underperforming both inflation and risk free returns.

During this rising interest rate period, the buy and hold equal asset allocation and timing model both deliver absolute returns slightly better than risk free rates however with much higher volatility. Reviewing the risk adjusted metrics, the timing model outperforms the buy and hold strategy demonstrating value in using a trend following strategy in a rising rates environment. The absolute returns may not be as attractive as other regimes, however the ability of the timing model to avoid drawdowns is responsible for helping to deliver the strong long term compounded returns seen over longer periods. Faber & Richardson (The Ivy Portfolio: How to Invest Like the Top Endowments and Avoid Bear Markets, 2009) identify that the value of a trend following timing model to add value needs to be recognised over the course of an entire business cycle.

Figure 14 - Performance under rising rates

Figure 15 - XYZ drawdowns 1973-1981

Table 9 - Performance Metrics

|  |  |  |
| --- | --- | --- |
|  | Buy and Hold | Timing |
| CAGR | 8.61% | 9.86% |
| Volatility | 10.79% | 8.14% |
| Skew | -0.33 | -0.80 |
| Kurtosis | 1.20 | 3.08 |
| Inflation CAGR | 9.23% | 9.23% |
| % in the Market | 100.00% | 68.07% |
| % positive Months | 60.55% | 69.72% |
| Best Month | 9.10% | 6.57% |
| Worst Month | -9.23% | -9.29% |
| Max Drawdown | -19.61% | -9.56% |
| Max Drawdown / CAGR | 2.28 | 0.97 |
| Sharpe Ratio (8.37%) | 0.00 | 0.14 |
| Sortino Ratio | 0.39 | 0.58 |
| MAR Ratio | 0.44 | 1.03 |
| Ulcer Index | 5.49 | 2.20 |

# Behavioural implications for Trend Following Investors

Despite delivering attractive returns, there are several behavioural implications for investors trading the trend following that make it difficult to trade.

Humans are subject to numerous behavioural biases. There are xyz behavioural biases.

They behavioural biases are known to interfere with the investment process and result in sub optimal investment decisions and sub optimal returns. Some of these are:

* Loss aversion / prospect theory: people feel pain of loss twice as much as they derive pleasure from an equal gain which leads to risk seeking in choices involving sure loses. We all have egos and its hard to admit we are wrong which is confirmed when exiting a trade, rather we hold onto losers.

A quantitative approach can help investors avoid all the behavioural biases humans make in their investment decision process (Faber & Richardson, The Ivy Portfolio: How to Invest Like the Top Endowments and Avoid Bear Markets, 2009).

Using a trend following strategy

Trend following strategies are difficult to trade:

* Despite delivering superior overall risk adjusted returns, trend following strategies underperform buy and hold strategies for long periods, especially during bull markets.
* They generally have a 30%-40% win ratio and can suffer multiple losing trades in a row (difficult for ego)

Market timing can underperform buy and hold strategies, especially in bull markets. Gray (Alpha Architect - Even God Would Get Fired As An Active Investor, 2016), researching the performance of optimal market timing strategies with hindsight, concludes that market timing strategies chosen with perfect foresight may have optimal returns but still show investor significant pain and drawdowns along the way. He concludes that investors must have a long horizon to stick to a market timing strategy and suggests few investors actually have that.

1. Has to be comfortable with the concept of diversification

* Diversification benefits well acknowledged however with the benefit of perfect hindsight, the performance results of a diversified portfolio are unlikely to be optimal. There will always be an asset class that underperforms and drags down the returns and if excluded in hindsight would have delivered better portfolio returns.
* Diversification is valuable because it deals with uncertainty. We don’t have perfect foresight and aren’t able to predict which asset classes to include or exclude.
* Diversification requires the investor to hold a long-term horizon. If the holding period is too short, the investor will not fully achieve the benefits of complementarity.

1. Has to be comfortable with the quantitative trend following approach

* TF strategy designed to manage risk – we don’t know what asset class will underperform so lets minimise its impact on the portfolio.
* TF designed to managed behavioural biases. Force us to cut losses.
* A simple rules based trend following system mitigates the potentially damaging behavioural biases that often lead to poor investment decisions.

1. Have to understand their emotions and have the discipline to stick to it

* Depite using a trend following strategy to manage biases, investors are likely to still have biases influence their decisions to trade the strategy
  + Neighbour bias / tracking error bias
* Investor needs to take account of their own behavioural biases
* Need to take a long term view and understand the strategy will exhibit tracking error to relative benchmarks in the short term.
* Disciplined to follow the rules, despite our emotions saying otherwise

Behavioural baeses lead to sub-optimal investment decisions.

A score of cognitive biases have been identified and used to explain investory behaviour including anchoring, confirmation bias, herding, overconfirdence…

Risk is measured in multiple ways and covered by several performance metrics such as those used in this paper. However there is another side of risk rarely acknowledged by traditional strategy performance analysis. Even following a quantitative approach designed to subdue bias, investors are likely to succumb to behavioural biases such as loss aversion and tracking error aversion. Trend following is known to have periods of underperformance and periods like now where equity markets are making news headlines for setting all time highs, are likely to result in some investors questioning their choice of strategy. Compounding the pressure will be when the investor chats to their neighbour who despite its popularilty is unlikely to be invested in a trend following strategy. Any underperformance will cause anxiety.

The quantitative approach is designed to help the investor avoid these behavioural biases taking control. Even if the approach is optimal, its of no use unless an investor can stick with it. An implication of the quantitative approach is that its boring. Black and Scholes (From Theory to a New Financial Product, 1973) report empirical evidence where investors rarely follow this rational approach. These investors, nicknamed gamblers, either enjoy the action of investing and derive a measure of utility from talking to their brokers, gathering information and trading buys and sells. Others, nicknamed the fools, wrongly believe they can make money by trading on information because they have been lucky in the past. Both investors are better off following a specific model but empirical evidence shows that they rarely are able to follow.

It seems for an investor to follow the trend following timing model a few unfront acknowledgements must be made upfront.

There are a variety of behavioural implication

Lets look behavioural etc. grass is always greener, herding, fear of missing out… advantages of systematic…

<http://rkaniel.simon.rochester.edu/papers/bubblesfin.pdf>  
<https://www.gsb.stanford.edu/insights/research-how-fear-missing-out-makes-investors-risk-blind>  
<http://macro-ops.com/avoiding-cognitive-biases-in-trading/>  
<http://macro-ops.com/plan-your-trades-and-trade-your-plan/>  
<https://www.tradingsetupsreview.com/10-cognitive-biases-plague-trader/>

Tracking error / loss / herding

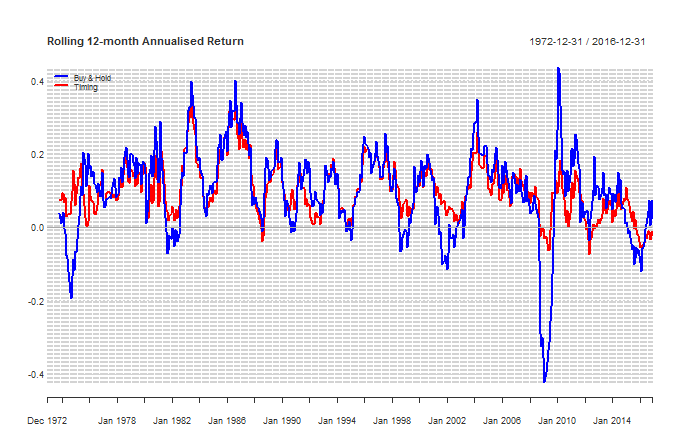
One of the well known behaviours of investors is that they fear tracking error, losing out

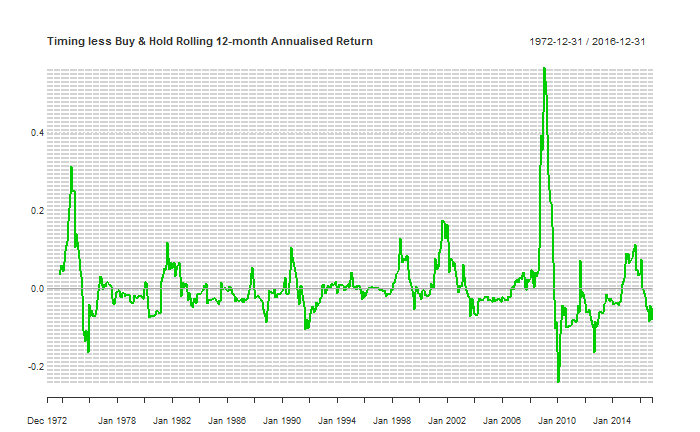
Model generally underperforms in bull markets but outperforms in volatility. The concept here is robust however there is no guarantee that past perofmance will continue. We can build confidence from the research, particularly from karminsky, that trends exist and the underlying concept is strong. Over time the strategy is likely to produce years of strong absolute returns but there is no guarantee that something signifcatn will prevent this in the future;

**A very simple quantitative strategy can avoid all the behavioural biases humans make in their investement making decision process (faber ivy book)**

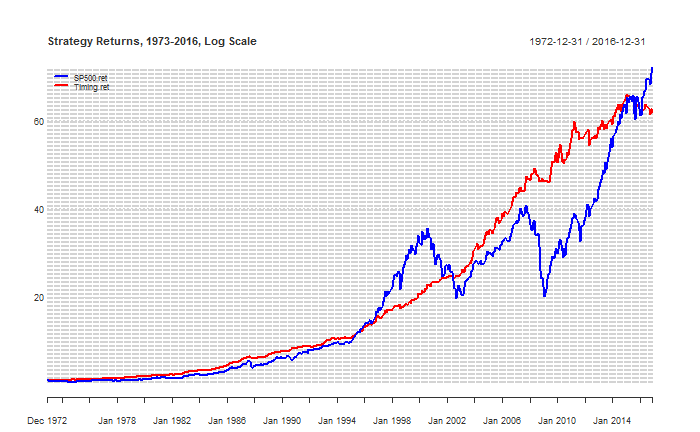
Different between trend following/absolute momentum and relative moment (stocks on the move

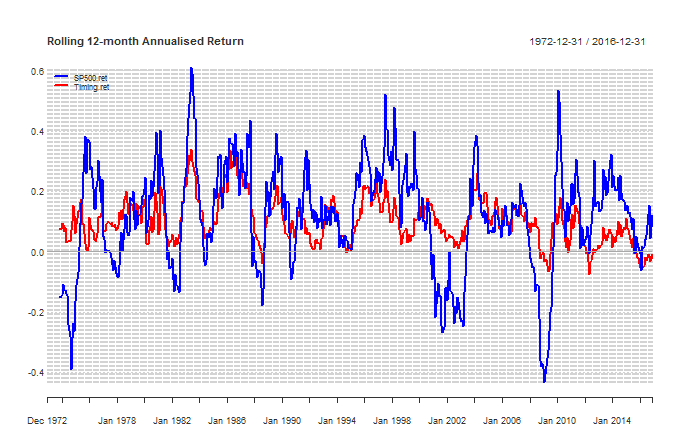
[taxes/fees/etc/biases]

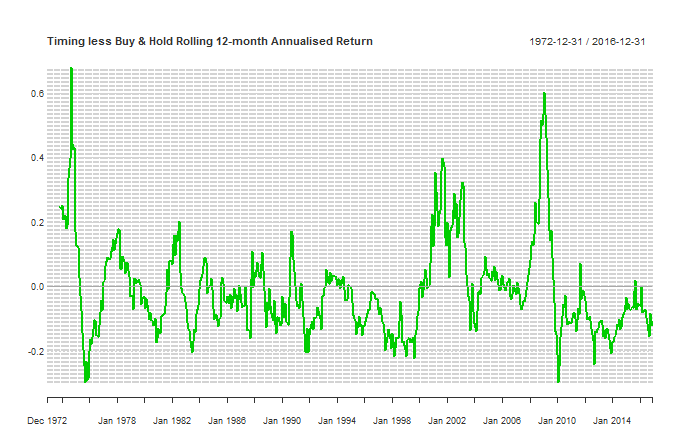




Difference to SP500:







# Improving returns

Over a long horizon, the market timing trend following quantitative approach provides superior risk adjusted returns compared to the buy and hold strategy. However no market timing strategy is profitable in all market conditions and Faber & Richardson (2009) identify that trend following timing strategies can underperform the buy and hold strategy around 40% of the time.

[insert rolling performance chart underperformance]

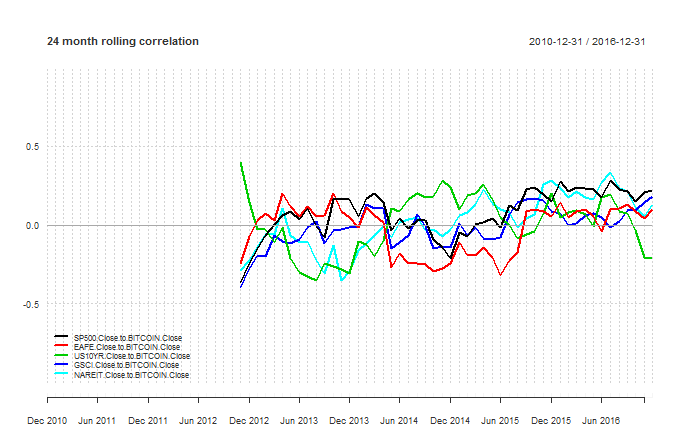
In this section I explore three areas to limit underperformance and achieve improved risk adjusted performance which overall may prove beneficial to the core timing model:

* Further asset allocation diversification
* Alternative trend following market timing strategies
* Diversification of trading strategies and parameters

## Asset Allocation Diversification

When investors hear the term diversification they generally think of the diversification of the underlying assets within their portfolio. Faber (2013) comments that his five asset class equal weighted asset allocation was chosen purely for simplicity. In the 2013 update he tests expanding the portfolio to a 13 asset portfolio of different allocations. As expected the additional assets improve the risk adjusted performance of both the buy and hold and timing strategy. Historically exposure to many asset classes were only available to institutions. However today there are hundreds of asset class investment products accessible to retail investors such as ETFs and mutual funds. It makes sense then to look at adding further asset classes that are low correlated to the existing strategy.

One such asset class worth investigating is Bitcoin, a cryptocurrency introduced in 2008. Bitcoin falls within the third superclass of assets known as store of value assets which generally serve as a refuge during uncertainty (Greer, 1997). Despite only having a short period of pricing history from late 2010, Bitcoin has so far demonstrated extremely low correlation to all other asset classes.



Bitcoin trades on multiple unregulated exchanges, has high volatility and only a relatively short history. Due to liquidity constraints, many large investment managers have little if any exposure making the asset class far less likely to suffer the effects of financialisation in market crises. For retail investors it appears an attractive asset to add into the asset allocation. Ultimately the length of pricing history is short and the asset has yet to experience a market crisis. Without falling subject to the law of small numbers and gambler’s fallacy (Tversky & Kahneman, 1971), its unwise to make predictions of the diversifying value of adding Bitcoin to the asset allocation just yet. However for investors who can handle its volatility it’s definitely one asset class worth keeping an eye on in the future to improve returns.

There are hundreds of possible combinations of asset classes and weightings that can be practically traded by all investors. Cilella (2015) tested the effects of diversification at asset level on performance by using a Monte Carlo approach to create 1000 different portfolios of 15, 25 and 40 instruments before then comparing strategy performance over 20 years. His results found two main observations. Firstly portfolios with a greater number of instruments generally resulted in better risk adjusted performance with higher CAGR and lower maximum drawdowns. Secondly he found that with a more diversified portfolio, there was less deviation in the results of the random portfolios. Although performance of portfolios of the same number of instruments was spread across a wide range, portfolios with greater diversification showed lower variability and more consistent results. Disregarding costs and other constraints, there is extensive research identifying the value of greater levels of portfolio level diversification. Apart from better risk adjusted performance, greater levels of diversification will result in less variability in the strategy and less periods of significant underperformance.

## Alternative Trend Following Strategies - Avoiding Whipsaws

The underlying system in Faber’s timing model is a trend following system based on a simple moving average. Trend following systems are designed to capture trends, however they are subject to periods of whipsaws. Whipsaws are… This results in trend following strategies having multiple losing trades in a row, increasing behavioural bias pressure to cut the strategy – humans don’t like being wrong.

Trend following strategies are designed to identify trends and react by entering trades that will stay with the trend for as long as it lasts. The trading philosophy doesn’t attempt to predict the bottom or top of a market but rather react to a price move and capture as much of the remainder while it lasts. A drawback with trend following strategies is that performance generally suffers in consolidating, non trending or range bound markets. These sideways moving markets generate several false entry signals as the price whipsaws and quickly moves through the moving average in both directions, resulting in multiple buy and sell signals and trades for a small loss each time. Ultimately these periods are responsible for the low overall 30-40% win rate of trend following strategies

[insert chart of one asset when whipsawing with performance/P&L]

On average the size of the winners when the market is trending is much greater than the several small losses, resulting in the positive expectancy of these types of strategies. To avoid whipsaws, there are a couple of methods that can be used which will be applied to the GTAA:

* Delayed entry
* Bands
* Slope of moving average

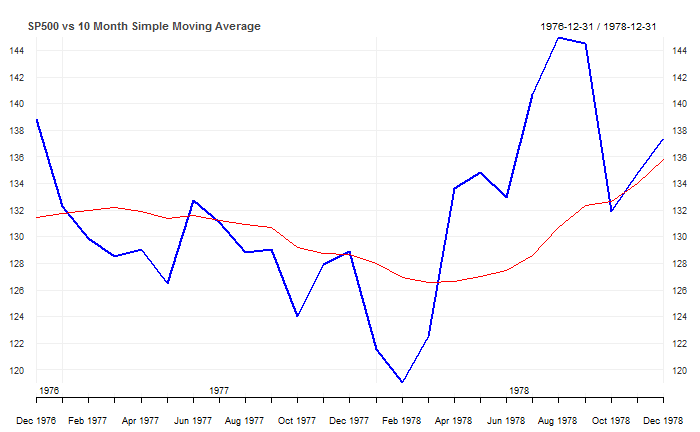
Ultimately these delay entry into a trade or require greater certainty that a trend is present. As a result they are generally in the market less, can miss short term whipsaws but at the expense of missing out of the first part of the move. However the avoidance of costly whipsaw periods in prolonged sideways moving markets can justify their use.

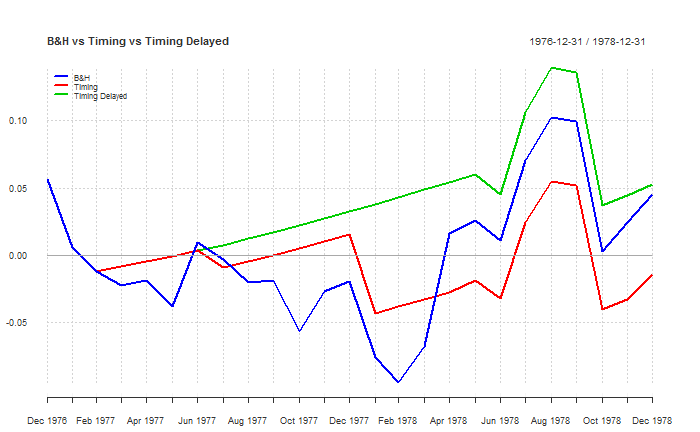
### Delayed entry

This method delays long entry for a set period after a long signal to confirm that the price is still above the moving average and has not fallen back below. It eliminates whipsaws at the expense of missing out of the first part of the move. The delay only applies to the entry of a long position, and if the price falls below the moving average, the position is closed out instantaneously. Looking at the SP500 for the entire period, the value of the strategy does not look significantly different to the timing strategy. Absolute and Risk Adjusted Return metrics are all in line, perhaps the biggest difference is that the strategy is in the market only 69.19% of the time vs the 74.67% of the timing strategy.

|  |  |  |  |
| --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed |
| CAGR | 10.19% | 10.35% | 10.03% |
| Volatility | 15.28% | 11.61% | 11.22% |
| Skew | -0.43 | -0.68 | -0.71 |
| Kurtosis | 1.97 | 5.19 | 6.13 |
| Inflation CAGR | 4.04% | 4.04% | 4.04% |
| % in the Market | 100.00% | 74.67% | 69.19% |
| % positive Months | 61.63% | 73.35% | 75.24% |
| Best Month | 16.81% | 13.47% | 13.47% |
| Worst Month | -21.54% | -21.54% | -21.54% |
| Max Drawdown | -50.95% | -23.29% | -23.26% |
| Max Drawdown / CAGR | 5.00 | 2.25 | 2.32 |
| Sharpe Ratio (4.93%) | 0.33 | 0.44 | 0.43 |
| Sortino Ratio | 0.32 | 0.42 | 0.42 |
| MAR Ratio | 0.20 | 0.44 | 0.43 |
| Ulcer Index | 14.45 | 6.19 | 5.93 |

Focusing on a specific period that the SP500 was subject to whipsaws in 1977-1978, the delayed timing strategy is much more hesitant to enter a long position when the price moves above the moving average. It is only in the market 32% of the time compared to 48% of the time for the Timing strategy. Absolute performance is positive as it ignores two opportunities to enter the market that the tradional timing model took and immediately got whipsawed out of the trade. [add buy and sell signals with quantstrat]





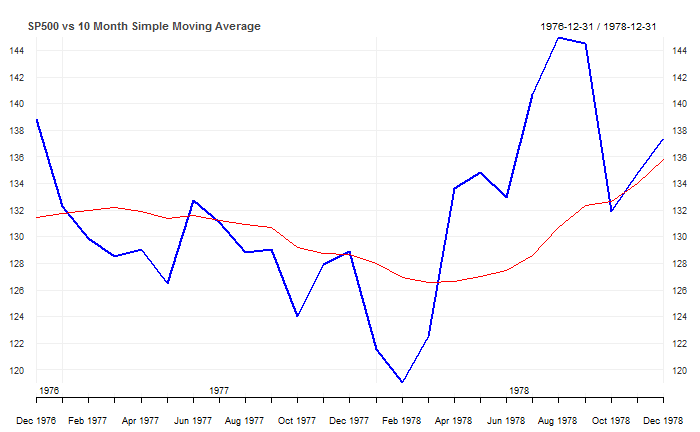
|  |  |  |  |
| --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed |
| CAGR | 2.13% | -0.67% | 2.48% |
| Volatility | 13.66% | 10.51% | 9.52% |
| Skew | 0.00 | -0.84 | -1.03 |
| Kurtosis | 0.09 | 1.93 | 3.81 |
| Inflation CAGR | 7.77% | 7.77% | 7.77% |
| % in the Market | 100.00% | 48.00% | 32.00% |
| % positive Months | 52.00% | 72.00% | 80.00% |
| Best Month | 9.02% | 5.84% | 5.84% |
| Worst Month | -8.72% | -8.72% | -8.72% |
| Max Drawdown | -14.26% | -9.39% | -9.01% |
| Max Drawdown / CAGR | 6.69 | -14.06 | 3.63 |
| Sharpe Ratio (4.93%) | -0.29 | -0.62 | -0.38 |
| Sortino Ratio | 0.10 | 0.00 | 0.12 |
| MAR Ratio | 0.15 | -0.07 | 0.28 |
| Ulcer Index | 7.29 | 6.23 | 4.37 |

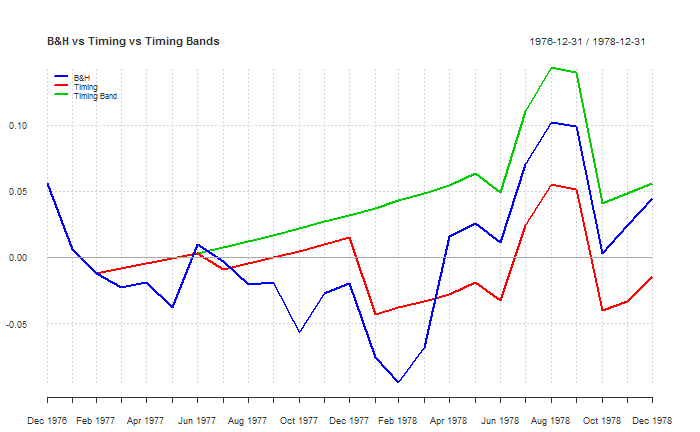
### Timing Band

Introduced in 1960 by Chester Keltner, this strategy is commonly known as the Keltner Channel Trading strategy. Similar to the delayed timing strategy, this strategy requires the price to demonstrate a stronger trend than just simply crossing above the moving average. Instead the price has to close a specific range above the simple moving average, in this example 102.5% of the moving average. Commonly the range is based on the ATR indicator however for simplicity in this research 102.5% was chosen – parameter stability was evident. In this example the exit is immediately when the price falls below the moving average. Overall the strategy aims to eliminate whips at the expense of missing out the first part of any trend. Looking at the SP500 for the entire period, the value of the strategy is slightly better than the original timing strategy with slightly higher CAGR and slightly lower volatility, resulting in improved risk adjusted return metrics. Again, the strategy is in the market for a less time – 70.89% of the time vs the 74.67% of the original timing strategy.

|  |  |  |  |
| --- | --- | --- | --- |
|  | B&H | Timing | Timing Band |
| CAGR | 10.19% | 10.35% | 10.96% |
| Volatility | 15.28% | 11.61% | 11.14% |
| Skew | -0.43 | -0.68 | -0.66 |
| Kurtosis | 1.97 | 5.19 | 6.13 |
| Inflation CAGR | 4.04% | 4.04% | 4.04% |
| % in the Market | 100.00% | 74.67% | 70.89% |
| % positive Months | 61.63% | 73.35% | 75.24% |
| Best Month | 16.81% | 13.47% | 13.47% |
| Worst Month | -21.54% | -21.54% | -21.54% |
| Max Drawdown | -50.95% | -23.29% | -23.29% |
| Max Drawdown / CAGR | 5.00 | 2.25 | 2.13 |
| Sharpe Ratio (4.93%) | 0.33 | 0.44 | 0.52 |
| Sortino Ratio | 0.32 | 0.42 | 0.47 |
| MAR Ratio | 0.20 | 0.44 | 0.47 |
| Ulcer Index | 14.45 | 6.19 | 5.36 |

Focusing on a specific period that the SP500 was subject to whipsaws in 1977-1978, the timing band makes it harder to enter a long position as the price closing just above the moving average is not strong enough to signal entry. It is in the market 36% of the time compared to 48% of the time for the original timing strategy. Absolute performance is positive as it ignores two opportunities to enter the market that the traditional timing model took and immediately got whipsawed out of the trade. [add 102.5% dotted line…]





|  |  |  |  |
| --- | --- | --- | --- |
|  | B&H | Timing | Timing Band |
| CAGR | 2.13% | -0.67% | 2.67% |
| Volatility | 13.66% | 10.51% | 9.53% |
| Skew | 0.00 | -0.84 | -1.05 |
| Kurtosis | 0.09 | 1.93 | 3.80 |
| Inflation CAGR | 7.77% | 7.77% | 7.77% |
| % in the Market | 100.00% | 48.00% | 36.00% |
| % positive Months | 52.00% | 72.00% | 80.00% |
| Best Month | 9.02% | 5.84% | 5.84% |
| Worst Month | -8.72% | -8.72% | -8.72% |
| Max Drawdown | -14.26% | -9.39% | -9.01% |
| Max Drawdown / CAGR | 6.69 | -14.06 | 3.37 |
| Sharpe Ratio (4.93%) | -0.29 | -0.62 | -0.36 |
| Sortino Ratio | 0.10 | 0.00 | 0.13 |
| MAR Ratio | 0.15 | -0.07 | 0.30 |
| Ulcer Index | 7.29 | 6.23 | 4.37 |

## Diversification of trading strategies and parameters

After exploring diversification of the underlying assets included within the portfolio, the next logical step is to explore diversification at a strategy level. For a buy and hold investment strategy, diversification is limited to the choice of assets included in the portfolio. In an active approach to investing, diversification can be applied to all variables within a trading strategy as well as by combining low correlated trading strategies themselves.

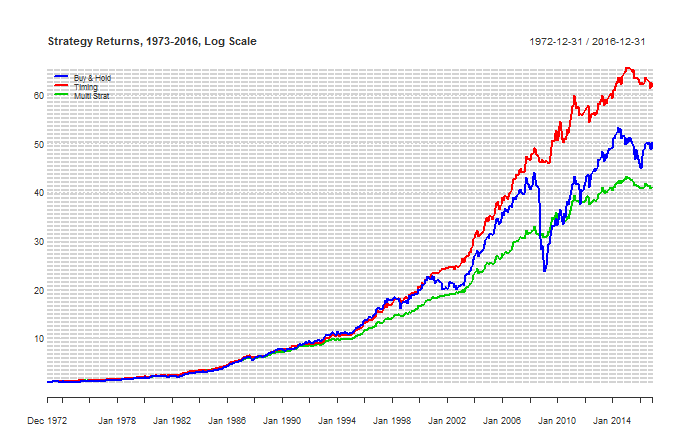
Peter Garnby (2016) demonstrates that combining weak individual trading strategies, which individually offer low risk adjusted returns, into a portfolio results in superior performance with much stronger risk adjusted returns. Over 500 trials he simulates blending 20 individual strategies each with individual Sharpe Ratios of 0.6 into portfolios that run for 10 years. Although absolute returns are not necessarily enhanced, he finds that portfolios of low correlated strategies return significantly improved risk adjusted performance with portfolio Sharpe Ratios of 3, a 370% improvement. The portfolio’s risk adjusted returns quickly decline as correlation increases, however the research shows the benefits of diversification can also be achieved by combining low correlated timing strategies.

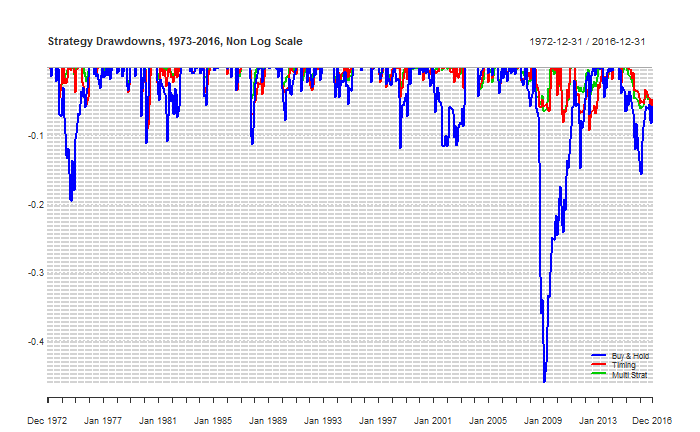
One of the simplest and most common ways to diversify Faber’s timing model would be by diversifying the moving average period used in the trend filter timing signal and effectively trade multiple time frames. Once created, these different time frame strategies can be combined into a superior portfolio. Faber (2013) acknowledges that stability of using various parameters for the moving average period. Faber uses the 10 month moving average and compares the returns to 3, 6, 9 and 12 month moving averages to find report similar risk adjusted returns. Another two popular time frames used in the trend following community are the 50 day and 100 day moving averages. Converted to monthly 2m and 5m time periods we see similar robustness in the strategy’s performance.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B&H | 2M Timing | 5M Timing | 10M Timing | Multi Timing |
| CAGR | 9.29% | 9.49% | 9.27% | 9.84% | 9.57% |
| Volatility | 10.09% | 6.29% | 6.62% | 6.87% | 6.14% |
| Skew | -1.02 | -0.07 | -0.51 | -0.48 | -0.25 |
| Kurtosis | 5.06 | 2.55 | 2.61 | 2.35 | 1.30 |
| Inflation CAGR | 4.04% | 4.04% | 4.04% | 4.04% | 4.04% |
| % in the Market | 100.00% | 59.89% | 65.48% | 70.81% | 0.00% |
| % Positive Months | 65.60% | 71.27% | 70.13% | 70.51% | 70.13% |
| Best Month | 9.22% | 9.22% | 6.57% | 6.58% | 6.18% |
| Worst Month | -19.34% | -7.96% | -9.29% | -9.29% | -6.11% |
| Max Drawdown | -46.10% | -13.29% | -10.71% | -9.56% | -8.65% |
| Max Drawdown / CAGR | 4.96 | 1.40 | 1.16 | 0.97 | 0.90 |
| Sharpe Ratio (4.93%) | 0.41 | 0.69 | 0.62 | 0.68 | 0.72 |
| Sortino Ratio | 0.42 | 0.83 | 0.71 | 0.73 | 0.84 |
| MAR Ratio | 0.20 | 0.71 | 0.87 | 1.03 | 1.11 |
| Ulcer Index | 7.95 | 2.39 | 2.66 | 2.36 | 2.11 |

Similar to Faber’s findings, each timing signal returns individual performance with similar absolute returns, volatility and risk adjusted measures such as Sharpe Ratio. Similar to multiple time frame analysis by Clenow (2013), the longer term strategies applied to multiple assets generally return stronger total returns however at the expense of having slightly higher volatility and more negative skew returns.   
Combining the three different time frames into an equal weighted portfolio, we see a slight improvement from the diversification effect as expected from Garnby’s research. The portfolio of multiple time frame strategies shows similar absolute returns of 9.57%. However volatility and maximum drawdown are the lowest of all time frames and as a result, risk adjusted measures such as Sharpe ratio, Sortino ratio, Calmar ratio and Ulcer index are all improved.

The idea of strategy diversification can be extended to include the other strategy ideas in this paper. A multi strategy portfolio consisting of equal weight exposure to the following strategies:

* 2m, 5m, 10m timing strategies
* 2m, 5m, 10m delayed timing strategies
* 2m, 5m, 10m trading band strategies



|  |  |  |  |
| --- | --- | --- | --- |
|  | B&H | Timing | Multi Strat |
| CAGR | 9.29% | 9.84% | 8.80% |
| Volatility | 10.09% | 6.87% | 5.49% |
| Skew | -1.02 | -0.48 | -0.33 |
| Kurtosis | 5.06 | 2.35 | 2.22 |
| Inflation CAGR | 4.04% | 4.04% | 4.04% |
| % in the Market | 100.00% | 70.81% | 55.04% |
| % positive Months | 65.60% | 70.51% | 72.02% |
| Best Month | 9.22% | 6.58% | 6.18% |
| Worst Month | -19.34% | -9.29% | -6.57% |
| Max Drawdown | -46.10% | -9.56% | -6.93% |
| Max Drawdown / CAGR | 4.96 | 0.97 | 0.79 |
| Sharpe Ratio (4.93%) | 0.41 | 0.68 | 0.67 |
| Sortino Ratio | 0.42 | 0.73 | 0.85 |
| MAR Ratio | 0.20 | 1.03 | 1.27 |
| Ulcer Index | 7.95 | 2.36 | 1.82 |

Although absolute returns are less but a whole percentage point, significant reductions in volatility and max drawdown may make this a more attractive option to a risk adverse investor. Potentially allows the investor to take on more leverage to achieve enhanced total returns for the same level of risk or maximum drawdown.

Note the above numbers exclude trading costs / taxes / etc talked about in practical considerations. Lastly all of the above ignores trading fees… Downside is costs/taxes however with these assets trading costs are assumed to be minimal and worth the better returns. Taxes also are fine – fabers comments about winners being longer, etc.

Anothre practical consideration to trading a combination of strategies to achieve the diversification benefit is that the investor may require a large capital base. Depending on the underlying instruments traded, contract sizes may have too large minimum sizes to get the small exposure required.

Optimisation

Although we have the technology to run through all parameters and solve which would have given us the best results (suffering from hindsight), we are unlikely to see the results in the future. As such optimisation isn’t suggested for any of the inputs.

The trading strategy relies on some core concepts. Diversification adds value, assets trend and get out of the market when they stop trending. Faber and the results above show that the length of the moving average used in the timing signal does not significantly change the underlying performance. Optimisation may produce strong historical results but at the expense of future performance.

Trend followers such as Ed Seykota are adamant there is no best system or holy grail (Covel, 2013).

The value in trend following strategies is not from picking the bottom or top of a trend but being able to ride the middle of the trend while minimalizing losses.

The rules and the criteria are incredibly varied and unique but at the end of the day they all attempt to do the same thing: catch the majority of a position move in an asset class. In essense were talking about momentum (faber ivy 141)

Can have multiple strategy diversification however needs to survive the cost of implementation. Simple is easier to follow.

# A Quantitative Approach to Tactical Asset Allocation in South Africa

South Africa has a very traditional investment industry that has lagged the world adopting recent investment trends such as indexation (Morningstar 2015). It is estimated that X% of funds invested are actively managed and of these funds a large majority are discretionary managed rather than quantitative. In this section I apply the quantitative approach to an equivalent South Africa asset allocation and compare to the top ranking managers.

## Data Used

The biggest challenge to apply the strategy to South Africa is obtaining a long enough period of historical price data for each asset class in South Africa. Ibbotson et al (2016) view long periods of data as vital for uncovering “the basic the relationships between risk and return among the different asset classes”. With a long enough period, the data will capture major market events as well as periods under different regimes such as growth and decline or inflation and deflation. Although history is unlikely to repeat, infamous market crashes and financial crises in different asset classes around the world are common throughout history all the way back to the seventeenth century with the infamous tulip bubble crash. In one way or another, despite the common view that markets walk a random path, it shows that history tends to repeat itself and a long period of data may hold some level of predictive value in the future.

Unfortunately for South Africa, historical performance data for each asset class is difficult to find for long periods of history and near impossible for asset classes such as property. Domestic equity market data is available from the Johannesburg Stock Exchange (JSE) going back to 1960 however even they cannot guarantee that the data is completely accurate as some of it was captured prior to the current FTSE/JSE joint venture in 2002. Previous local research (Firer & McLeod, 1999) found that before 1960 data was never systematically collected and published. It was found during research for this paper, that previous work collecting data (including that done by Firer & McLeod) had generally been lost over time, either from the researcher changing career paths or unfortunately in one case passing away. Copies of data handed down researcher to researcher exist, however the validity of some of this data is questionable especially when reviewing and comparing overlapping time periods between multiple data sets and finding inconsistencies.

To create long data sets of historical returns for South African asset classes, I have used the best quality most recent data spliced to the most reliable of the available older data. This is summarised by the following table.

|  |  |
| --- | --- |
|  | Source |
| Domestic Equities | 2002-2016: FTSE/JSE All Share Total Return Index (Bloomberg - JALSHTR Index) |
| 1970-2002: JSE/Actuaries All Share Index with dividends allocated evenly over the year (provided by the JSE) |
| Foreign Equities | 1971-2016: MSCI EAFE Total Return Index in ZAR (Bloomberg - GDDUEAFE Index) |
| Fixed Income | 2002-2016: JSE ALBI Total return index (Bloomberg – SYG5TR INDEX) |
| 1972-2016: Total return index created using Long-Term Government Bond Yields for South Africa: 10-year (FRED – IRLTLT01ZAM156N) |
| Commodities | 1971-2016: S&P GSCI Total Return Index in ZAR (Bloomberg - SPGSCITR Index) |
| Property | 2002-2016: FTSE/JSE SA Listed Property Total Return Index (Bloomberg - TJSAPYZ INDEX) |
| 1992-2002: Property sector Total Return Index (provided by a local asset manager) |
| Inflation | 1971-2016: South Africa CPI Index (Statistics South Africa) |
| Risk Free | 1971-2016: Risk free / Cash index created using Treasury Bill Yields for South Africa (FRED – INTGSTZAM193N) |

## South African Asset Class Returns excluding Real Estate (1971-2016)

[redo with log charts]

Figure 16 - South Africa Asset Class Returns 1972-2016, Log Scale

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | TBILLS | JALSH | MSCIWORLD | SA10YR | GSCI |
| Return | 10.53% | 18.48% | 15.87% | 12.00% | 13.60% |
| Volatility | 1.26% | 20.99% | 17.42% | 7.35% | 22.88% |
| Sharpe (10.53%) | 0.00 | 0.34 | 0.28 | 0.18 | 0.12 |
| MaxDD | 0.00% | -42.45% | -49.90% | -18.63% | -64.08% |
| Inflation CAGR | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% |

[rewrite summary and compare to US]

Reviewing the performance of asset classes in South Africa during 1972 – 2016, domestic equities have the strongest absolute CAGR of 18.48% followed by foreign equities with 15.87%. Commodities still return 13.60% for the period, highlighting the currency hedging effect a weakening ZAR has boosting returns in local currency. It’s also noteworthy that SA has much higher inflation and risk free rate than the original US asset allocation.

## Timing Signal

Let’s look at the asset returns individually and how the timing signal affect returns. It’s interesting to note with South Africa assets that the timing model consistently resulted in better risk adjusted returns, usually by a reduction in volatility than better absolute returns. JALSH was an exception – it had a worse MaxDD and equal Sharpe Ratio. [rewrite and mention this is where using multiple period moving averages or delayed entry would solve]

Add commentary summary for all assets:

* Again slightly less CAGR but less volatility and higher sharp / lower drawdown.
* Interesting drawdown is the same – unusual for this strategy but have checked its real
* Timing model doesn’t add much value in this case
* There is always exceptions to any rule and it appears JALSH bucks the trend with the timing model not return significantly better risk adjusted returns. Analysing why – 1988
* Demonstrates power of compounding after an early loss
* Much better results for the timing model in all performance measures
* Much better results for the timing model in all performance measures
* Most measures better.
* Interesting that the ZAR improves returns compared to USD GSCI

### JALSH – South African Domestic Equities

Figure 17 - JALSH Strategy Returns 1972-2016, Log Scale

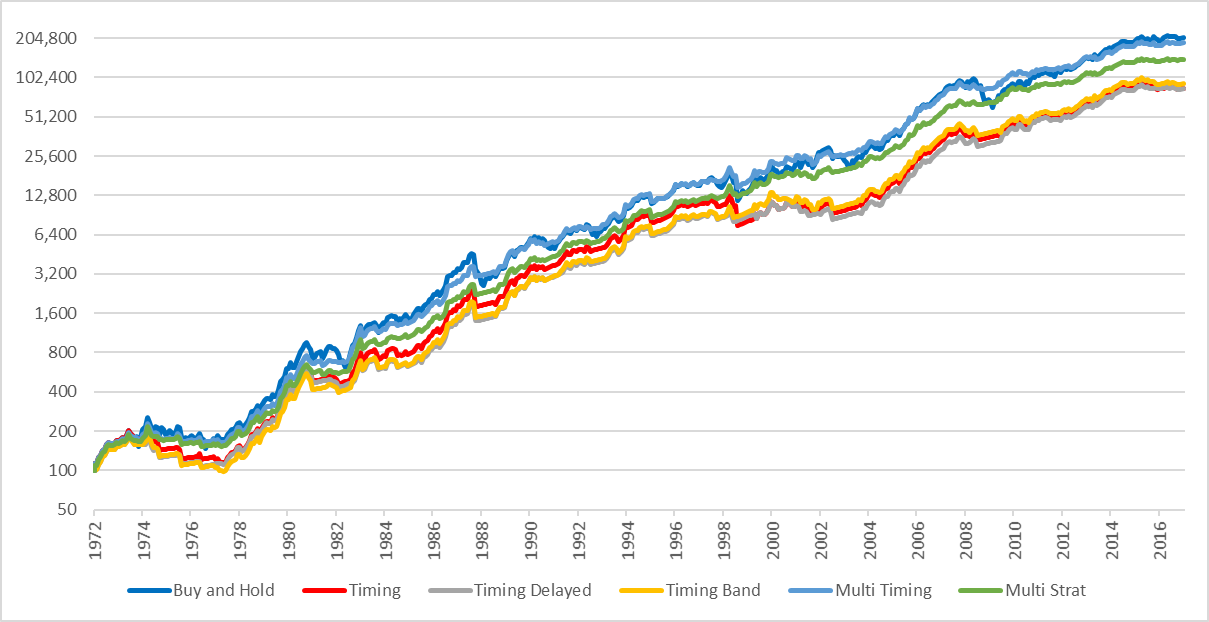


Figure 18 - JALSH Strategy Drawdowns 1972-2016, Non-log scale

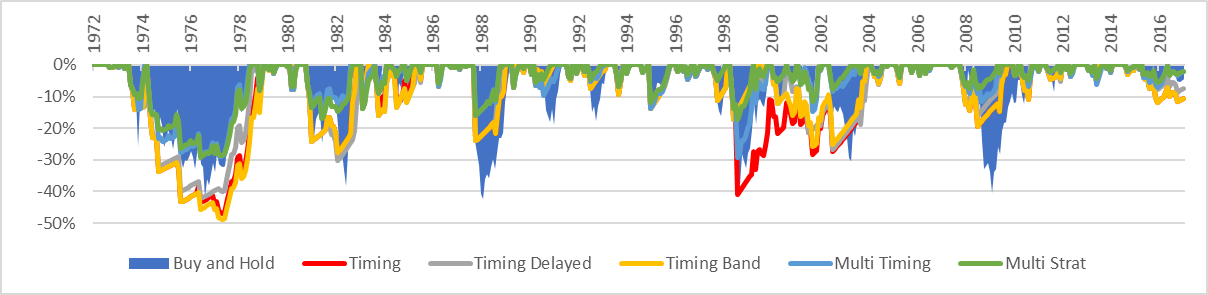


Table 10 - JALSH Strategy Performance Metrics 1972-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed | Timing Band | Multi Timing | Multi Strat |
| CAGR | 18.64% | 16.13% | 16.12% | 16.34% | 18.29% | 17.50% |
| Volatility | 20.99% | 17.26% | 15.96% | 16.48% | 14.90% | 13.36% |
| Skew | -0.45 | -0.66 | -0.32 | -0.28 | 0.01 | 0.20 |
| Kurtosis | 1.70 | 4.40 | 3.04 | 2.52 | 2.57 | 2.66 |
| Inflation CAGR | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% |
| % in the Market | 100.00% | 75.42% | 69.32% | 73.75% | 69.38% | 62.88% |
| % positive Months | 61.92% | 71.53% | 74.12% | 71.90% | 69.87% | 71.16% |
| Best Month | 18.28% | 17.70% | 17.70% | 17.70% | 17.70% | 17.18% |
| Worst Month | -29.58% | -29.58% | -23.41% | -23.41% | -19.19% | -15.37% |
| Max Drawdown | -42.45% | -47.02% | -42.34% | -48.98% | -29.30% | -29.16% |
| Max Drawdown / CAGR | 2.28 | 2.91 | 2.63 | 3.00 | 1.60 | 1.67 |
| Sharpe Ratio (10.52%) | 0.34 | 0.30 | 0.32 | 0.32 | 0.47 | 0.47 |
| Sortino Ratio | 0.44 | 0.45 | 0.50 | 0.49 | 0.65 | 0.71 |
| MAR Ratio | 0.44 | 0.34 | 0.38 | 0.33 | 0.62 | 0.60 |
| Ulcer Index | 13.12 | 16.58 | 14.63 | 16.47 | 9.07 | 8.52 |

### MSCIWORLD – Foreign Developed Equities (in ZAR)

Figure 19 – MSCIWORLD (ZAR) Strategy Returns 1972-2016, Log Scale

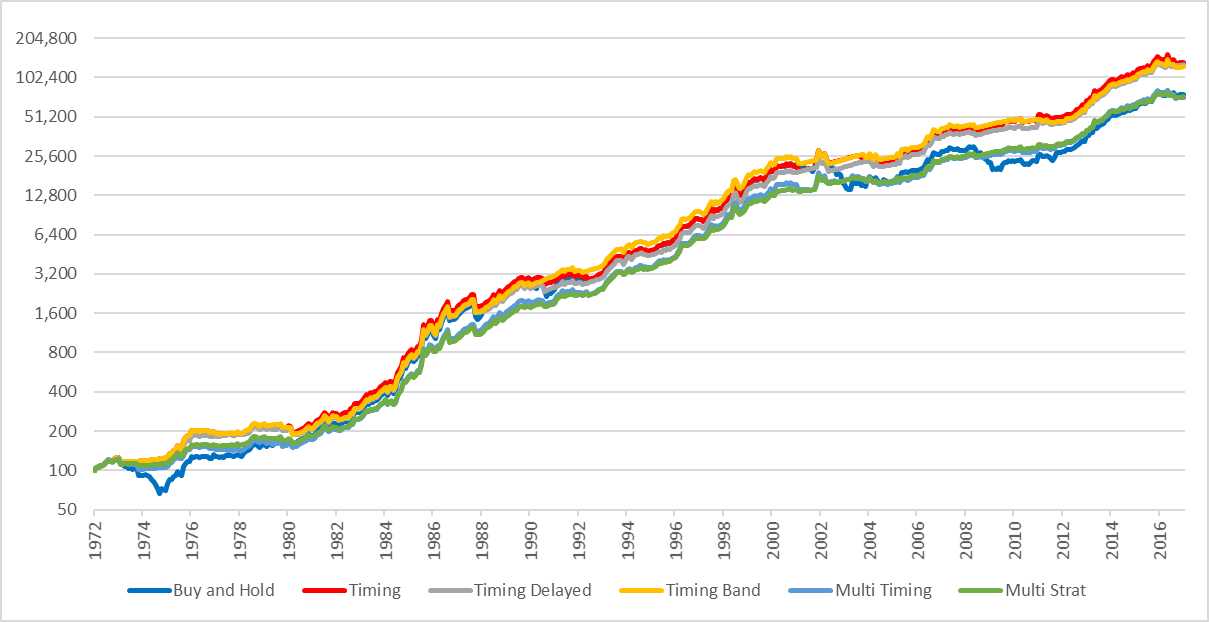


Figure 20 – MSCIWORLD (ZAR) Strategy Drawdowns 1972-2016, Non-log scale

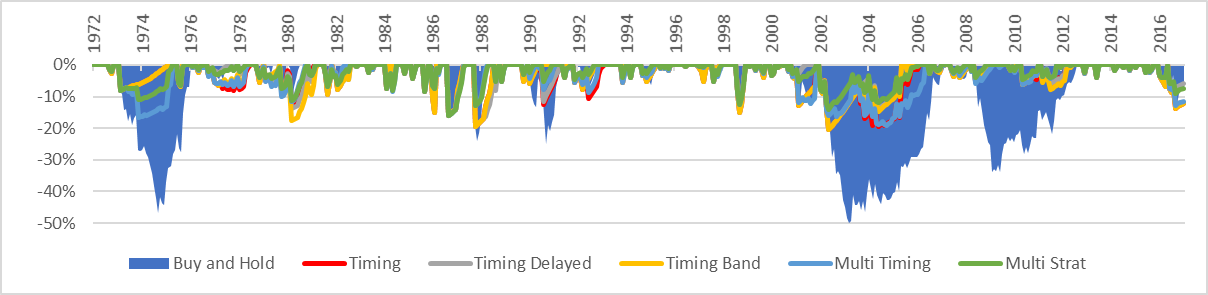


Table 11 – MSCIWORLD (ZAR) Strategy Performance Metrics 1972-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed | Timing Band | Multi Timing | Multi Strat |
| CAGR | 16.25% | 17.33% | 17.22% | 17.12% | 15.86% | 15.79% |
| Volatility | 17.57% | 15.07% | 14.55% | 14.62% | 13.53% | 12.28% |
| Skew | 0.40 | 0.69 | 0.78 | 0.74 | 0.88 | 1.14 |
| Kurtosis | 2.94 | 5.86 | 6.83 | 6.62 | 7.33 | 10.45 |
| Inflation CAGR | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% |
| % in the Market | 100.00% | 77.45% | 71.90% | 73.20% | 70.92% | 61.72% |
| % positive Months | 62.85% | 73.57% | 75.79% | 75.60% | 71.72% | 74.49% |
| Best Month | 29.19% | 29.19% | 29.19% | 29.19% | 29.19% | 29.19% |
| Worst Month | -19.43% | -19.43% | -19.43% | -19.43% | -16.09% | -16.09% |
| Max Drawdown | -49.90% | -20.54% | -20.54% | -20.54% | -19.17% | -16.09% |
| Max Drawdown / CAGR | 3.07 | 1.19 | 1.19 | 1.20 | 1.21 | 1.02 |
| Sharpe Ratio (10.52%) | 0.28 | 0.41 | 0.42 | 0.41 | 0.35 | 0.39 |
| Sortino Ratio | 0.50 | 0.64 | 0.66 | 0.65 | 0.65 | 0.73 |
| MAR Ratio | 0.33 | 0.84 | 0.84 | 0.83 | 0.83 | 0.98 |
| Ulcer Index | 17.14 | 6.06 | 5.16 | 5.64 | 6.17 | 4.22 |

### SA10YR – Fixed Income

Figure 21 – SA10YR Strategy Returns 1972-2016, Log Scale

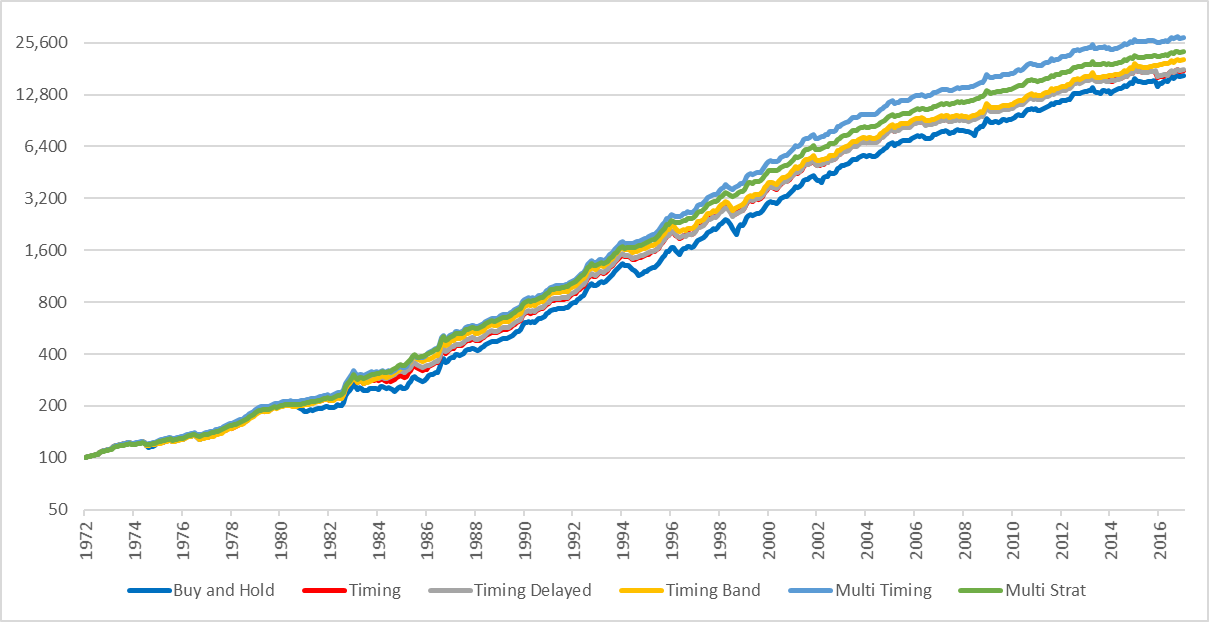


Figure 22 – SA10YR Strategy Drawdowns 1972-2016, Non-log scale

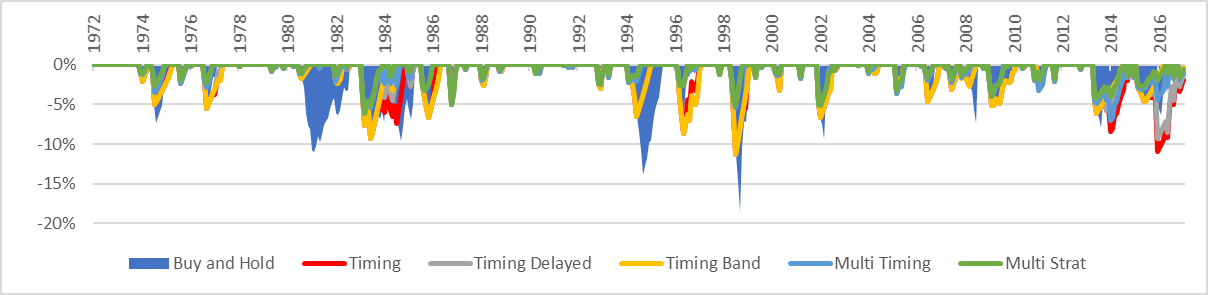


Table 11 – SA10YR Strategy Performance Metrics 1972-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed | Timing Band | Multi Timing | Multi Strat |
| CAGR | 12.00% | 12.19% | 12.20% | 12.53% | 13.28% | 12.80% |
| Volatility | 7.35% | 6.62% | 6.50% | 6.32% | 5.93% | 5.27% |
| Skew | 0.20 | 0.05 | 0.06 | 0.17 | 0.44 | 0.47 |
| Kurtosis | 1.82 | 2.21 | 2.48 | 2.48 | 2.71 | 3.64 |
| Inflation CAGR | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% |
| % in the Market | 100.00% | 87.43% | 83.36% | 0.00% | 80.28% | 67.53% |
| % positive Months | 73.57% | 77.82% | 78.93% | 80.22% | 80.96% | 84.47% |
| Best Month | 10.14% | 9.09% | 9.09% | 9.09% | 9.09% | 9.09% |
| Worst Month | -6.67% | -6.67% | -6.67% | -5.14% | -5.03% | -5.03% |
| Max Drawdown | -18.63% | -11.35% | -11.35% | -11.35% | -7.06% | -6.14% |
| Max Drawdown / CAGR | 1.55 | 0.93 | 0.93 | 0.91 | 0.53 | 0.48 |
| Sharpe Ratio (10.52%) | 0.18 | 0.23 | 0.23 | 0.29 | 0.42 | 0.39 |
| Sortino Ratio | 0.94 | 1.05 | 1.07 | 1.17 | 1.49 | 1.66 |
| MAR Ratio | 0.64 | 1.07 | 1.07 | 1.10 | 1.88 | 2.08 |
| Ulcer Index | 3.47 | 2.70 | 2.51 | 2.28 | 1.48 | 1.21 |

### GSCI – Commodities (in ZAR)

Figure 23 – GSCI (ZAR) Strategy Returns 1972-2016, Log Scale

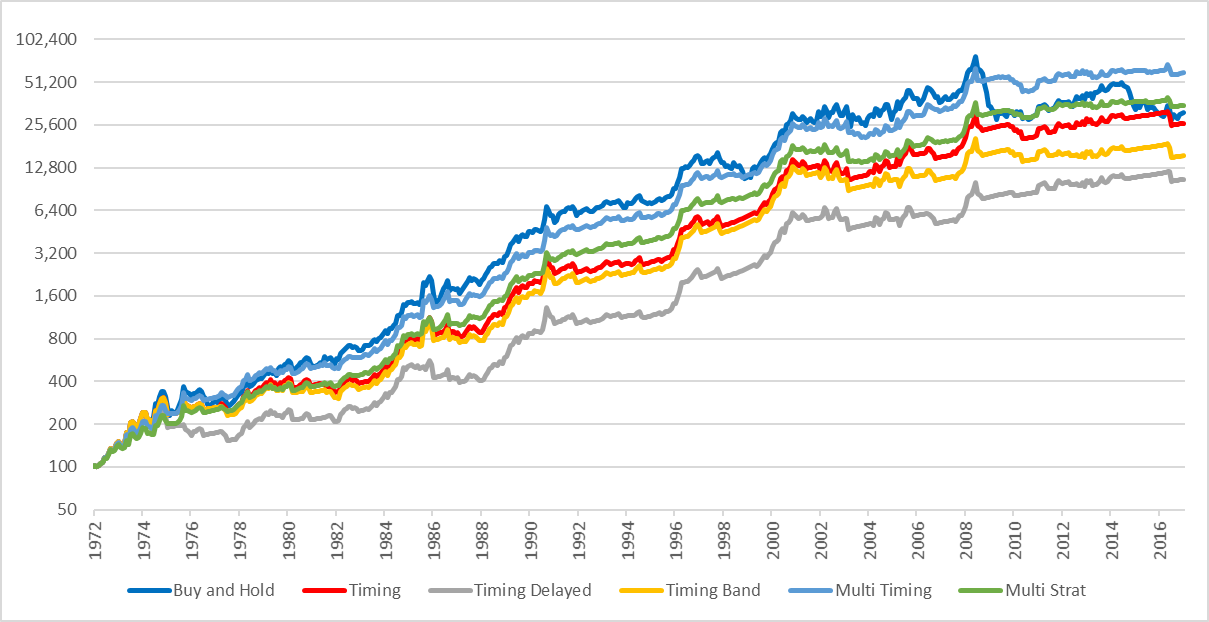


Figure 24 – GSCI (ZAR) Strategy Drawdowns 1972-2016, Non-log scale

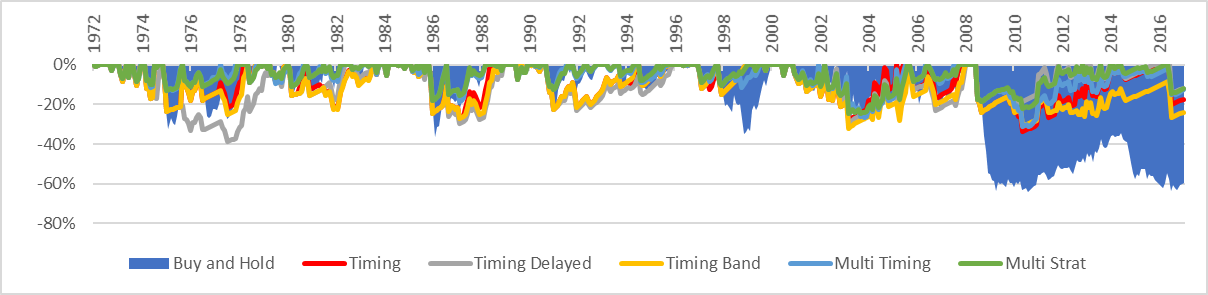


Table 13 – GSCI (ZAR) Strategy Performance Metrics 1972-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed | Timing Band | Multi Timing | Multi Strat |
| CAGR | 13.85% | 13.42% | 11.16% | 12.11% | 15.49% | 14.14% |
| Volatility | 22.91% | 19.04% | 17.38% | 18.75% | 17.11% | 15.22% |
| Skew | 0.21 | 0.59 | 0.20 | 0.63 | 0.88 | 0.51 |
| Kurtosis | 1.48 | 4.13 | 3.58 | 4.52 | 5.03 | 4.31 |
| Inflation CAGR | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% |
| % in the Market | 100.00% | 69.32% | 62.29% | 65.62% | 64.94% | 56.48% |
| % positive Months | 59.89% | 72.46% | 74.68% | 73.38% | 70.24% | 71.90% |
| Best Month | 30.09% | 30.09% | 25.90% | 30.09% | 30.09% | 22.72% |
| Worst Month | -19.15% | -19.15% | -19.15% | -19.15% | -17.57% | -17.57% |
| Max Drawdown | -64.08% | -33.50% | -38.71% | -32.06% | -30.96% | -24.64% |
| Max Drawdown / CAGR | 4.63 | 2.50 | 3.47 | 2.65 | 2.00 | 1.74 |
| Sharpe Ratio (10.52%) | 0.12 | 0.13 | 0.02 | 0.06 | 0.25 | 0.20 |
| Sortino Ratio | 0.33 | 0.38 | 0.33 | 0.35 | 0.51 | 0.50 |
| MAR Ratio | 0.22 | 0.40 | 0.29 | 0.38 | 0.50 | 0.57 |
| Ulcer Index | 30.20 | 12.36 | 14.62 | 13.72 | 8.98 | 7.86 |

### Systematic Tactical Asset Allocation South Africa (1972-2016)

Figure 25 – Systematic Tactical Asset Allocation Strategy Returns 1972-2016, Log Scale

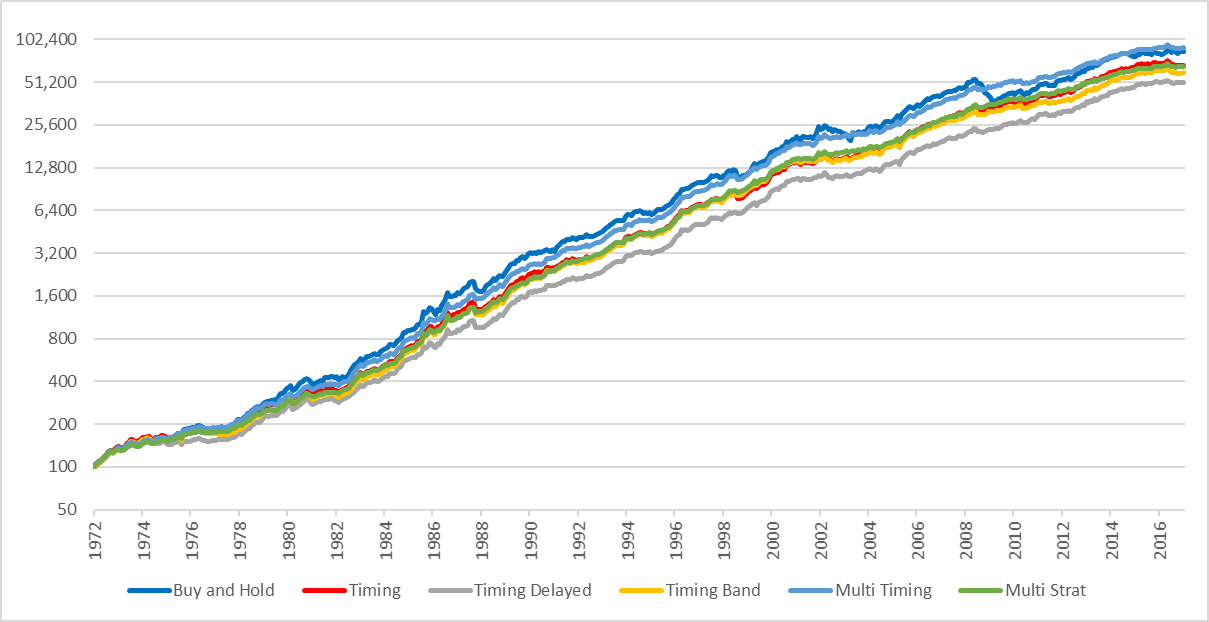


Figure 26 – Systematic Tactical Asset Allocation Strategy Drawdowns 1972-2016, Non-log scale

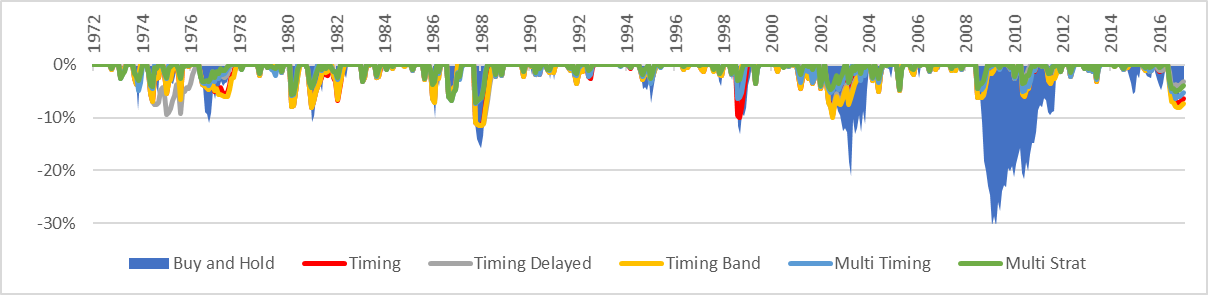


Table 13 – Systematic Tactical Asset Allocation Strategy Performance Metrics 1972-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed | Timing Band | Multi Timing | Multi Strat |
| CAGR | 16.36% | 15.63% | 14.92% | 15.32% | 16.39% | 15.59% |
| Volatility | 10.95% | 8.76% | 7.96% | 8.54% | 7.87% | 7.01% |
| Skew | 0.05 | 0.08 | -0.18 | 0.19 | 0.36 | 0.32 |
| Kurtosis | 1.74 | 3.96 | 2.52 | 4.14 | 3.36 | 3.31 |
| Inflation CAGR | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% | 9.48% |
| % in the Market | 100.00% | 77.40% | 71.72% | 73.24% | 71.38% | 61.93% |
| % positive Months | 66.54% | 71.90% | 73.20% | 72.27% | 74.86% | 75.23% |
| Best Month | 16.34% | 16.34% | 10.33% | 16.34% | 15.11% | 12.71% |
| Worst Month | -10.98% | -10.98% | -10.98% | -10.98% | -7.29% | -7.15% |
| Max Drawdown | -30.61% | -11.59% | -11.59% | -11.59% | -7.29% | -7.15% |
| Max Drawdown / CAGR | 1.87 | 0.74 | 0.78 | 0.76 | 0.44 | 0.46 |
| Sharpe Ratio (10.52%) | 0.47 | 0.52 | 0.50 | 0.51 | 0.67 | 0.65 |
| Sortino Ratio | 0.83 | 1.01 | 1.07 | 1.04 | 1.32 | 1.45 |
| MAR Ratio | 0.53 | 1.35 | 1.29 | 1.32 | 2.25 | 2.18 |
| Ulcer Index | 6.35 | 2.60 | 2.58 | 2.60 | 1.74 | 1.47 |

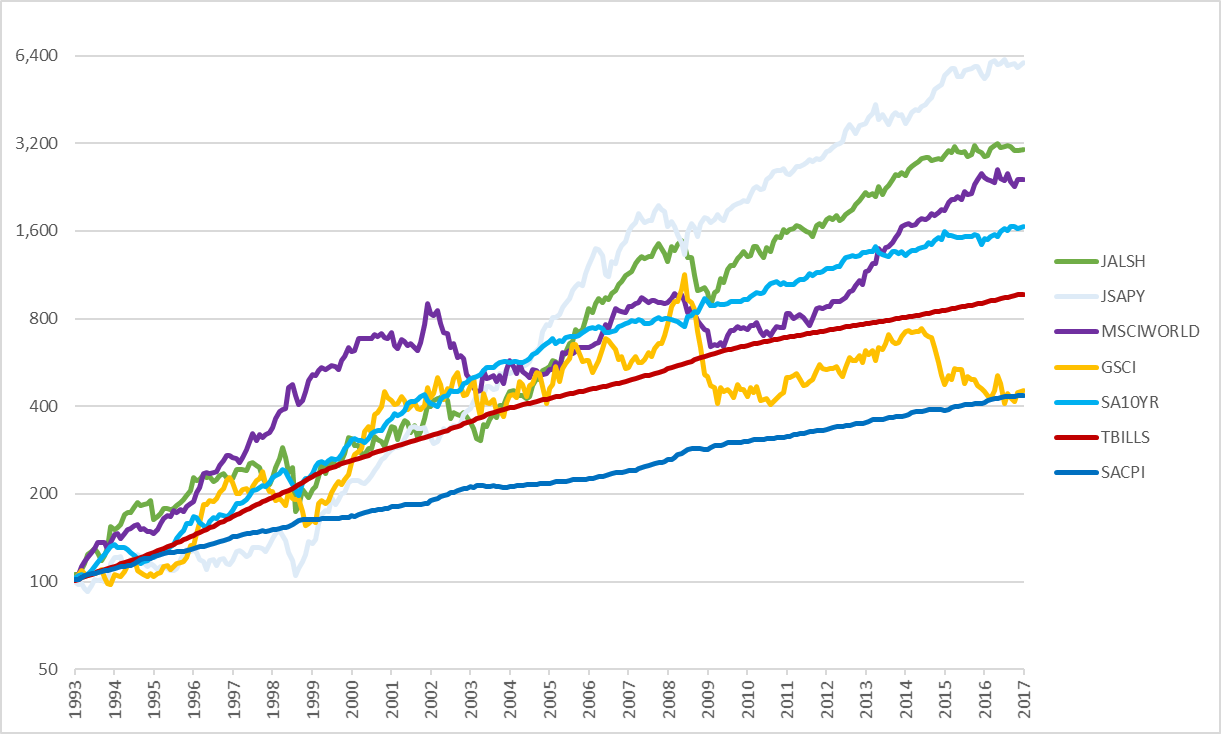
The absolute returns of the timing strategy are slightly worse however a larger drop in volatility results in a higher sharpe ratio. Importantly for investors, the biggest drawdown is 11.59%, approximately a third of the buy and hold. Risk adjusted measures are all much better than the buy and hold.

Look at rolling returns / annual returns vs benchmark

## South African Asset Class Returns including Real Estate (1993-2016)

Adding real estate to the asset allocation can only be done from 1993. Property unavailable…

Figure 27 - South African Asset Class Returns 1993-2016, Log scale



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | TBILLS | JALSH | MSCIWORLD | SA10YR | GSCI | JASPY |
| Return | 9.84% | 14.59% | 13.54% | 11.74% | 6.85% | 19.40% |
| Volatility | 1.01% | 18.37% | 16.32% | 8.04% | 23.01% | 15.85% |
| Sharpe (9.84%) | -0.14 | 0.23 | 0.20 | 0.19 | -0.13 | 0.54 |
| MaxDD | 0.00% | -40.44% | -49.90% | -18.63% | -64.08% | -31.87% |
| Inflation CAGR | 6.19% | 6.19% | 6.19% | 6.19% | 6.19% | 6.19% |

Reviewing the most recent 22 years, which includes data on Real Estate, shows that over this period Real Estate has returned much stronger absolute and risk adjusted returns than the other asset classes. Commodities again have the lowest absolute returns, despite having the highest volatility. GSCI returns of 6.91% are just higher than inflation which has reduced by approximately a third compared to the previous period.

### JSAPY – South African Real Estate

Figure 28 – JSAPY Strategy Returns 1994-2016, Log Scale

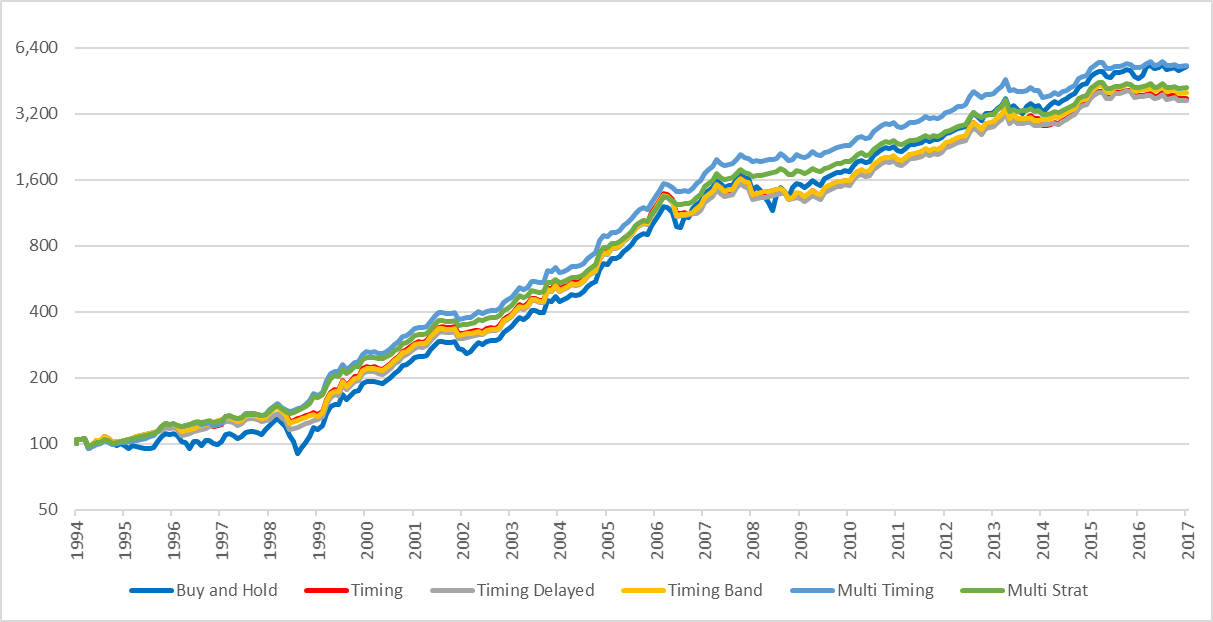


Figure 29 – JSAPY Strategy Drawdowns 1994-2016, Non-log scale

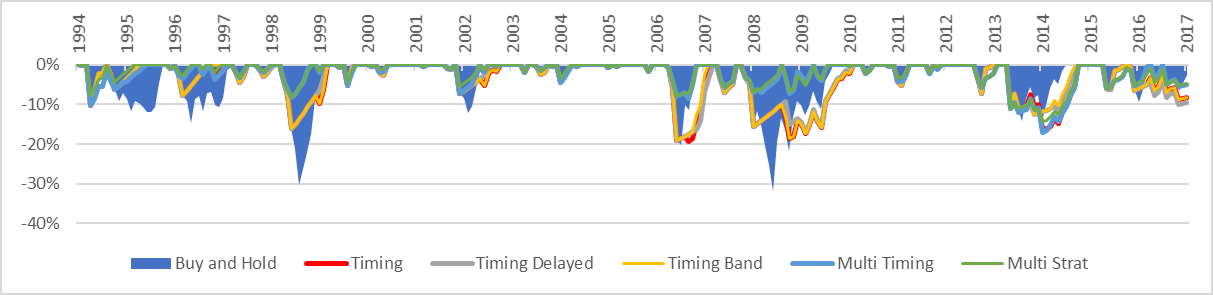


Table 13 – JSAPY Strategy Performance Metrics 1994-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed | Timing Band | Multi Timing | Multi Strat |
| CAGR | 19.40% | 17.71% | 17.60% | 18.02% | 19.24% | 17.93% |
| Volatility | 15.85% | 13.26% | 12.87% | 13.02% | 11.53% | 10.27% |
| Skew | -0.05 | -0.18 | -0.15 | -0.17 | 0.11 | 0.12 |
| Kurtosis | 1.15 | 2.35 | 2.86 | 2.62 | 2.01 | 2.14 |
| Inflation CAGR | 6.19% | 6.19% | 6.19% | 6.19% | 6.19% | 6.19% |
| % in the Market | 100.00% | 81.23% | 76.17% | 79.42% | 74.25% | 66.75% |
| % positive Months | 66.07% | 74.01% | 76.17% | 75.09% | 74.37% | 74.73% |
| Best Month | 18.19% | 14.52% | 14.52% | 14.52% | 13.45% | 13.42% |
| Worst Month | -13.93% | -13.93% | -13.93% | -13.93% | -11.09% | -11.09% |
| Max Drawdown | -31.87% | -19.25% | -19.00% | -19.00% | -17.02% | -14.34% |
| Max Drawdown / CAGR | 1.64 | 1.09 | 1.08 | 1.05 | 0.88 | 0.80 |
| Sharpe Ratio (9.84%) | 0.55 | 0.54 | 0.55 | 0.57 | 0.75 | 0.72 |
| Sortino Ratio | 0.64 | 0.67 | 0.69 | 0.70 | 0.94 | 1.00 |
| MAR Ratio | 0.61 | 0.92 | 0.93 | 0.95 | 1.13 | 1.25 |
| Ulcer Index | 7.15 | 6.41 | 6.14 | 6.13 | 4.04 | 3.64 |

### Systematic Tactical Asset Allocation South Africa including Real Estate (1994-2016)

Figure 25 – Systematic Tactical Asset Allocation Strategy Returns 1994-2016, Log Scale

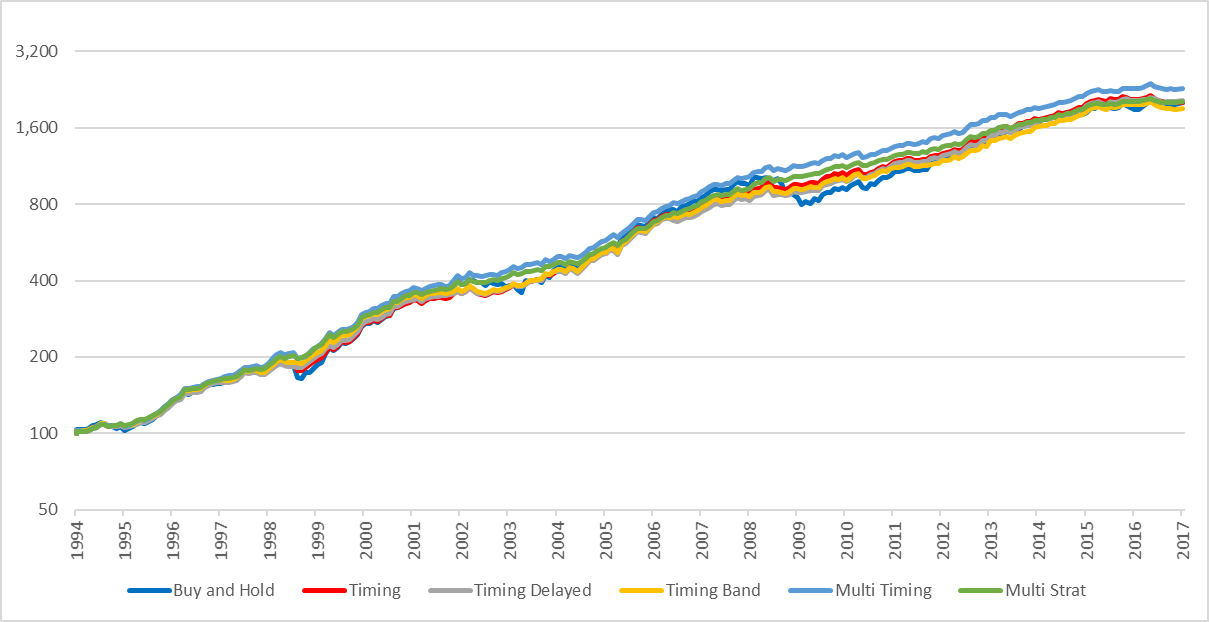


Figure 26 – Systematic Tactical Asset Allocation Strategy Drawdowns 1994-2016, Non-log scale

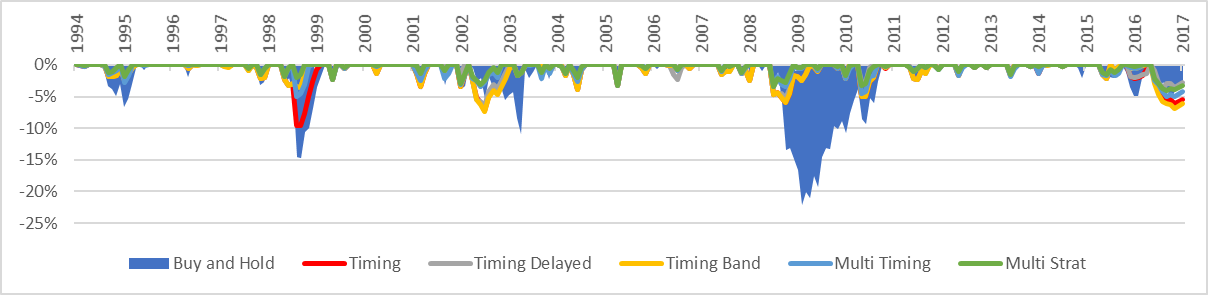


Table 13 – Systematic Tactical Asset Allocation Strategy Performance Metrics 1994-2016

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B&H | Timing | Timing Delayed | Timing Band | Multi Timing | Multi Strat |
| CAGR | 14.28% | 14.30% | 14.35% | 14.03% | 14.85% | 14.20% |
| Volatility | 9.44% | 7.04% | 6.47% | 6.70% | 6.29% | 5.44% |
| Skew | -0.11 | 0.03 | 0.42 | 0.21 | -0.03 | 0.11 |
| Kurtosis | 1.88 | 1.31 | 1.25 | 1.00 | 0.84 | 0.86 |
| Inflation CAGR | 6.19% | 6.19% | 6.19% | 6.19% | 6.19% | 6.19% |
| % in the Market | 100.00% | 76.17% | 70.54% | 72.42% | 70.11% | 60.87% |
| % positive Months | 65.34% | 71.48% | 74.01% | 72.56% | 75.09% | 76.17% |
| Best Month | 11.52% | 8.42% | 8.42% | 8.42% | 7.16% | 6.83% |
| Worst Month | -10.90% | -6.72% | -4.69% | -4.92% | -4.81% | -3.40% |
| Max Drawdown | -22.19% | -9.59% | -6.51% | -7.41% | -5.05% | -4.08% |
| Max Drawdown / CAGR | 1.55 | 0.67 | 0.45 | 0.53 | 0.34 | 0.29 |
| Sharpe Ratio (9.84%) | 0.43 | 0.58 | 0.64 | 0.57 | 0.73 | 0.73 |
| Sortino Ratio | 0.84 | 1.27 | 1.60 | 1.39 | 1.55 | 1.89 |
| MAR Ratio | 0.64 | 1.49 | 2.21 | 1.89 | 2.94 | 3.48 |
| Ulcer Index | 4.66 | 1.95 | 1.42 | 1.76 | 1.24 | 0.94 |

Including Real Estate, the timing strategy is slightly better/equal to the buy and hold. Again the timing strategy’s volatility is lower and max drawdown is still in the single figures. The value of the other timing strategies are highlighted over this period. The multi strat has a max drawdown of 3.67%, and a MaxDD/CAGR ratio of 0.25. In other words it would take a quarter of an average years performance to recover from its maxdd. [word of warning max dd is always in the future, similar to fabers original research]

Although performance metrics exhibit solid performance over a basket of US assets, when applied to South Africa its clear the timing strategy outperformance isn’t as strong. Why? Is it a case of overfitting in Faber’s paper, or a unique case where trend following rules don’t apply to a south Africa asset allocation?

Lastly as Faber has pointed out, diversification can also somewhat improve returns, again at a cost of increased taxes/trading fees.

* Diversifying with more asset classes:
  + We have only looked at asset classes in these example. Clare et all (2012 pg 8) research shows splitting an asset class into its components parts add value. Although perhaps too time consuming for retail investors, institutional investors could target better risk adjusted returns applying these strategies on individual assets within these broad asset classes.
  + Also add different asset classes – comment on how more and more is becoming available. Perhaps bitcoin as an example of an uncorrelated asset that could improve results.Diversifying using more moving average periods
* Using EMA
* Using vol filter
* Long and short (pg 158 faber ivy)
* Overlaying a mean reverting
* Pyramid in / out approach
* Signal has to be 1% above or below to change
* No bonds – already exposed to fixed income through treasuries – can remove and increase returns. However this will remove downside?
* High vol asset classes give better returns on a timing strategy (faber ivy 2009)

On analysis it appears the performance of the Systematic Tactical Asset Allocation with South Africa assets suffers due to domestic equities in the late 1970s. [Questionable data? – look to confirm]

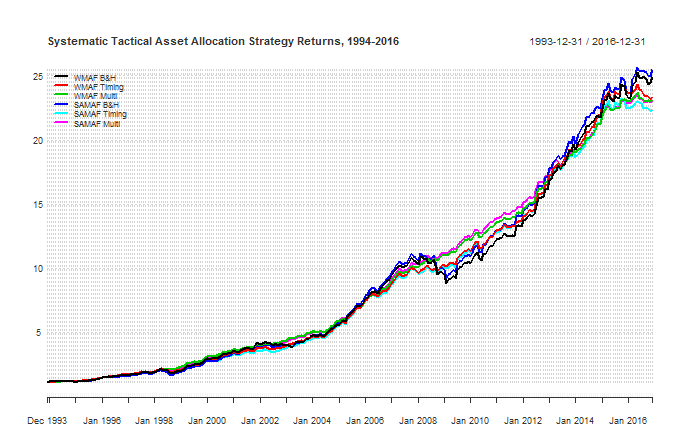
Look at:

* adding more assets (can’t no data?) and   
  diversifying the moving average to longer and shorter signals
* look at exponential moving average

## Comparison to South African funds

Retail funds in South Africa are known as Collective Investment Schemes (CISs) and are regulated under the Collective Investment Schemes Control Act 2002 (CISCA). Funds are then categorised according to classifications specified by the Association for Savings and Investment South Africa (ASISA), an industry body which assists the Financial Services Board with the regulation of the industry. ASISA uses a three-tier classification system focusing on geographically where the fund will be invested (tier 1), what assets the fund invests in (tier 2) and then what the main focus of the fund will be (tier 3). One of the objectives of ASISA’s classification system is to facilitate the comparison of funds both across and within categories.

To compare the performance of the market timing strategy against comparative funds, the asset allocation has to be adjusted to fit within specific classification constraints. Two potential fund classifications that would only require minor reweighting to the equal weighted original allocation are Worldwide Multi Asset Flexible portfolios and South Africa Multi Asset High Equity portfolios. Ultimately the differences between each classification are minimal are seen in the following chart.



### Worldwide Multi Asset Flexible Returns

To fit within the Worldwide Mule Asset Flexible classification, the asset allocation has relative little constraints from ASISA. No minimum is set for domestic or foreign assets and they have complete flexibility in their asset allocation between and within asset class. Only CISCA regulations apply which in this case restricts commodity exposure to 10% [need to confirm this is the only constraint applicable here]. As such the following asset allocation has been selected:

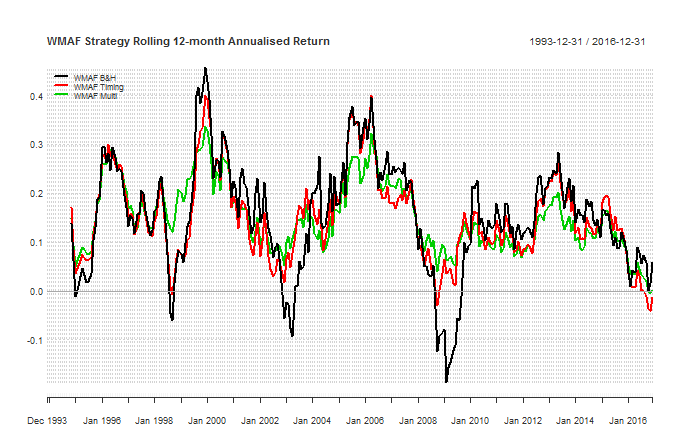
* 22.5% Domestic Equity
* 22.5% Foreign Equity
* 22.5% Fixed Income
* 22.5% Property
* 10.0% Commodities

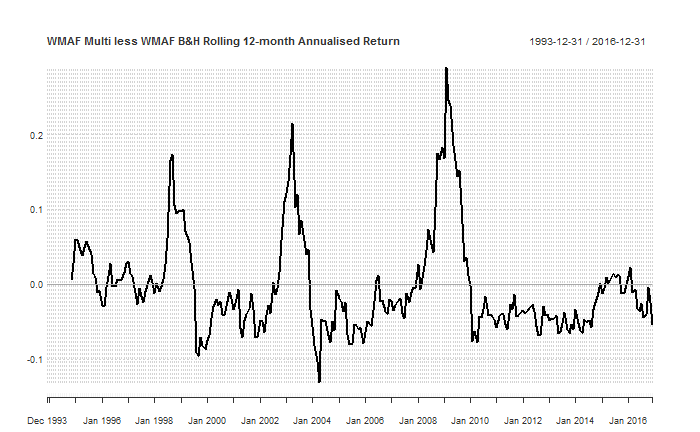
When comparing returns between the different strategies we see very strong performance from the multi strategy.

|  |  |  |  |
| --- | --- | --- | --- |
|  | WMAF B&H | WMAF Timing | WMAF Multi |
| CAGR | 14.95% | 14.63% | 14.59% |
| Volatility | 9.22% | 7.00% | 5.30% |
| Skew | -0.24 | 0.07 | 0.32 |
| Kurtosis | 2.44 | 1.82 | 0.96 |
| Inflation CAGR | 6.19% | 6.19% | 6.19% |
| % in the Market | 100.00% | 78.38% | 62.38% |
| % positive Months | 69.68% | 72.56% | 80.51% |
| Best Month | 10.33% | 9.36% | 7.28% |
| Worst Month | -12.14% | -7.75% | -2.93% |
| Max Drawdown | -18.75% | -11.52% | -2.93% |
| Max Drawdown / CAGR | 1.25 | 0.79 | 0.20 |
| Sharpe Ratio (9.84%) | 0.51 | 0.63 | 0.82 |
| Sortino Ratio | 0.90 | 1.34 | 2.21 |
| MAR Ratio | 0.80 | 1.27 | 4.99 |
| Ulcer Index | 3.77 | 1.89 | 0.72 |

Annual returns

|  |  |  |  |
| --- | --- | --- | --- |
|  | WMAF B&H | WMAF Timing | WMAF Multi |
| 1994 | 6.29% | 8.53% | 9.33% |
| 1995 | 19.27% | 19.69% | 18.60% |
| 1996 | 17.10% | 19.18% | 20.55% |
| 1997 | 12.50% | 11.29% | 12.95% |
| 1998 | 8.29% | 8.56% | 20.85% |
| 1999 | 45.86% | 40.00% | 33.83% |
| 2000 | 19.23% | 17.05% | 17.14% |
| 2001 | 22.99% | 14.03% | 15.14% |
| 2002 | -5.61% | 1.84% | 5.35% |
| 2003 | 17.68% | 18.47% | 15.35% |
| 2004 | 17.53% | 19.37% | 16.83% |
| 2005 | 33.53% | 31.00% | 23.49% |
| 2006 | 23.87% | 18.14% | 21.73% |
| 2007 | 15.83% | 16.15% | 15.32% |
| 2008 | -8.47% | 3.71% | 9.51% |
| 2009 | 9.24% | 12.14% | 11.54% |
| 2010 | 13.75% | 10.32% | 8.70% |
| 2011 | 10.60% | 7.28% | 6.86% |
| 2012 | 21.65% | 21.21% | 16.99% |
| 2013 | 21.54% | 19.22% | 14.42% |
| 2014 | 10.89% | 11.72% | 11.19% |
| 2015 | 8.25% | 7.72% | 8.50% |
| 2016 | 5.82% | -1.26% | 0.28% |





### South Africa Multi Asset Flexible Returns

To fit within the South Africa Multi Asset Flexible classification, the fund must effectively invest at least 75% of their assets in South African investment markets considering a maximum of 25% of their assets can be assets outside of south Africa. [is there a commodity index or offshore equity index listed locally that counts as local?]. Combined with CISCA regulations, the following asset allocation has been selected:

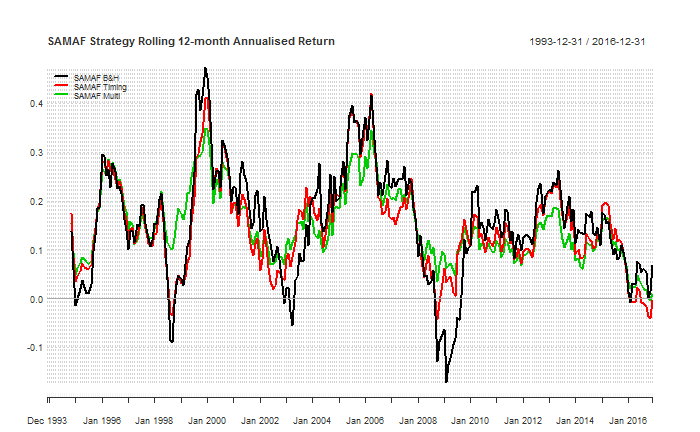
* 25.0% Domestic Equity
* 15.0% Foreign Equity
* 25.0% Fixed Income
* 25.0% Property
* 10.0% Commodities

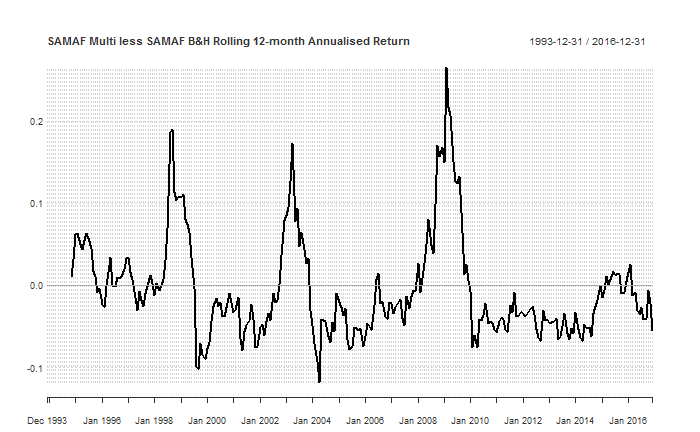
When comparing performance statistics, we see:

|  |  |  |  |
| --- | --- | --- | --- |
|  | SAMAF B&H | SAMAF Timing | SAMAF Multi |
| CAGR | 15.06% | 14.42% | 14.57% |
| Volatility | 9.22% | 7.13% | 5.36% |
| Skew | -0.30 | 0.10 | 0.41 |
| Kurtosis | 2.67 | 1.88 | 1.04 |
| Inflation CAGR | 6.19% | 6.19% | 6.19% |
| % in the Market | 100.00% | 78.79% | 62.71% |
| % positive Months | 70.40% | 72.92% | 78.70% |
| Best Month | 9.63% | 9.80% | 7.28% |
| Worst Month | -12.61% | -7.76% | -2.71% |
| Max Drawdown | -19.22% | -13.62% | -3.76% |
| Max Drawdown / CAGR | 1.28 | 0.94 | 0.26 |
| Sharpe Ratio (9.84%) | 0.52 | 0.59 | 0.81 |
| Sortino Ratio | 0.90 | 1.27 | 2.25 |
| MAR Ratio | 0.78 | 1.06 | 3.87 |
| Ulcer Index | 3.57 | 2.17 | 0.75 |

Annual returns

|  |  |  |  |
| --- | --- | --- | --- |
|  | SAMAF B&H | SAMAF Timing | SAMAF Multi |
| 1994 | 5.93% | 8.42% | 9.40% |
| 1995 | 18.64% | 19.48% | 18.49% |
| 1996 | 13.98% | 16.25% | 17.94% |
| 1997 | 11.92% | 10.64% | 12.38% |
| 1998 | 4.85% | 4.71% | 18.47% |
| 1999 | 47.38% | 41.01% | 34.80% |
| 2000 | 19.84% | 17.41% | 17.66% |
| 2001 | 22.12% | 12.40% | 13.88% |
| 2002 | -1.03% | 3.75% | 7.06% |
| 2003 | 19.27% | 20.89% | 17.11% |
| 2004 | 19.87% | 21.61% | 18.92% |
| 2005 | 34.48% | 32.13% | 24.93% |
| 2006 | 23.22% | 16.92% | 21.18% |
| 2007 | 16.52% | 16.68% | 15.88% |
| 2008 | -7.33% | 3.20% | 9.62% |
| 2009 | 10.23% | 12.17% | 11.78% |
| 2010 | 15.40% | 11.83% | 9.76% |
| 2011 | 9.88% | 7.17% | 6.73% |
| 2012 | 21.81% | 21.36% | 16.99% |
| 2013 | 18.31% | 15.93% | 11.58% |
| 2014 | 10.91% | 11.46% | 11.14% |
| 2015 | 6.13% | 5.40% | 6.88% |
| 2016 | 6.81% | -0.34% | 1.15% |
|  |  |  |  |





How do these compare to similar classification funds in South Africa? [get more info from peregrine/pres/seed]

Morningstar is an investment research firm that provides performance reporting of ASISA funds in South Africa. Each month they release performance figures comparing funds of the same ASISA classification. Comparing each strategy to the peers we see mixed results with some periods of outperformance and some periods of underperformance.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 3m | 6m | 1yr | 3yr | 5yr | 7yr | 10yr |
| Peer Group Average | -1.41% | -1.56% | -3.75% | 7.31% | 13.95% | 12.02% | 9.74% |
| WMAF B&H | 3.93% | 0.82% | 5.80% | 8.29% | 13.42% | 13.07% | 10.59% |
| WMAF Timing | -0.41% | -4.36% | -1.25% | 5.92% | 11.42% | 10.66% | 10.63% |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 3m | 6m | 1yr | 3yr | 5yr | 7yr | 10yr |
| Peer Group Average | -1.27% | -0.40% | 1.72% | 5.50% | 10.82% | 10.28% | 8.87% |
| SAMAF B&H | 3.26% | 0.92% | 6.83% | 7.94% | 12.62% | 12.62% | 10.57% |
| SAMAF Timing | -1.27% | -3.62% | -0.33% | 5.39% | 10.49% | 10.20% | 10.30% |

# Conclusion

The purpose of this paper was to replicate, analyse and extend Mebane Faber’s A Quantitative Approach to Asset Allocation before applying the model and any extensions on a South African asset allocation.

In this paper I suggest improvements to the original timing strategy and provide evidence that combining strategy parameters and timing strategies can generate a significant improvement in risk adjusted performance when compared to the buy and hold and original timing strategy independently.

Strategy level diversification may offer substantial long term value.

# Appendix 1 – Data validity check

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | TBILLS | SP500 | EAFE | US10YR | GSCI | NAREIT |
| Return | 5.42% | 9.77% | 9.19% | 8.12% | 8.34% | 9.64% |
| Volatility | 0.95% | 15.71% | 17.60% | 8.47% | 20.55% | 18.16% |
| Sharpe (??%) | 0.00 | 0.26 | 0.20 | 0.30 | 0.13 | 0.22 |
| MaxDD | 0.00% | -50.95% | -56.40% | -15.75% | -67.65% | -68.18% |
| Inflation CAGR | 4.33% | 4.33% | 4.33% | 4.33% | 4.33% | 4.33% |

Comparing to Fabers original numbers we see these small differences: (should this be in appendix with a comment saying comfortable obtained data represents the same asset classes?)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | TBILLS | SP500 | EAFE | US10YR | GSCI | NAREIT |
| Return | 0.01% | 0.07% | 0.02% | -0.06% | 0.02% | -0.01% |
| Volatility | 0.00% | 0.02% | -0.01% | 0.03% | 0.00% | 0.03% |
| Sharpe | 0.00 | -0.01 | -0.01 | -0.03 | -0.01 | -0.01 |
|  | 0.00% | 0.00% | 0.00% | 0.04% | 0.00% | -0.30% |
| Inflation CAGR | 0.03% | 0.03% | 0.03% | 0.03% | 0.03% | 0.03% |

Differences to fabers original research 1973-2012

Differences here to the original paper are small:

* Differences in returns <0.07%
* Differences in volatility <0.03%

Suspect this is from small differences between data providers. Comfortable using for rest of research.

# Appendix 2 – Review of R

One of the goals of this masters was to learn a new programming language R. R is an open source language widely used by data scientists for analysis in a wide variety of fields. Initiated in 1997, R has grown in popularity along with an ever increasing number of packages available that extend the base R functions.

My experience using R over the last 9 months has been mixed. Despite being relatively fluent in other programming languages and generally very competent with computers, R proved to have a very steep learning curve. Supported of R say this is an unavoidable byproduct of the languages power and flexibility however it is also related to the minimal graphical user interface and requirement to enter everything via command line. Based around S, a language written in 1970, R can be clunky and difficult to use and is code based unless you install a third party GUI. Multiple hours were spent installing R, RStudio and learning the basics and understanding the general workflow. Installing packages especially on computers with strict proxies and firewalls also soaked up time.

R has many advantages; it’s free, powerful for data analysis, open source and supported online by a large active user base. Unfortunately, one of the drawbacks to this is that support can be slow and finding solutions or debugging code can be frustrating. Support was found from a variety of sources – online forums, mailing lists, IRC chats as simply searching the internet to find solutions on sites such as stackoverflow.

One of the biggest strengths of working with R was packages. Packages are user created bundles of code, that add specialist functions to the base R code. For example all performance metrics in the report was the result of one package, with many metrics requiring a simple line of code identifying returns to calculate CAGRs, Sharpe Ratios, and max drawdowns. A summary of the packages used can be found below.

One issue I found with using packages is that updates can occur and remove previous functionality. For example the package performanceanalytics, which provides several functions for analysing portfolio performance, updated it graphs to use xyz. This resulted in several charts no longer displaying as originally designed, with simple things such as date formats no longer working to more critical things such as being unable to display on a log y axis.

There are a variety of courses available online from coursera, datacamp as well as a book R4DS that I would recommend for anyone interested in exploring R further.

Packages used:

|  |  |
| --- | --- |
| PerformanceAnalytics | Collection of econometric functions for performance and risk analysis |
| Quantmod | Charting, downloading of data from FRED, yahoo finance. |
| Quantstrat | Functions for building trading strategies |
| Dplyr / Tidyverse |  |
| Rblpapi |  |
|  |  |
|  |  |

# References

Antonacci, G. (2017). *Are Commodities Still a Good Portfolio Diversifier?* Retrieved Jan 2017, from http://www.dualmomentum.net/2017/01/are-commodities-still-good-portfolio.html

Bacon, C. (2004). *Practical Portfolio Performance Measurement and Attribution.*

Bhardwaj, G., Gorton, G., & Rouwenhorst, G. (2015). *Facts and Fantasies About Commodity Futures Ten Years Later.*

Black, F., & Scholes, M. (1973). From Theory to a New Financial Product. *The Journal of Finance, 29*(2), 399-412.

Cheung, S., & Miu, P. (2010). Diversification benefits of commodity futures. *Journal of International Financial Markets, Institutions & Money*, 451-474.

Clenow, A. (2013). *Following the Trend.*

Clenow, A. F. (2015). *Stocks on the Move: Beating the Market with Hedge Fund Momentum Strategies.*

Covel, M. W. (2013). *Trend Following.*

Domanski, D., & Heath, A. (2007). Financial Investors and Commodity Markets. *BIS Quarterly Review*(March), 53-67.

Erb, C. B., & Harvey, C. R. (2006). The Strategic and Tactical Value of Commodity Futures. *Financial Analysts Journal, 62*, 69-97.

Faber, M. (2007). A Quantitative Approach to Tactical Asset Allocation. *The Journal of Wealth Management*(Spring), 69-79.

Faber, M. (2009). *A Quantitative Approach To Tactical Asset Allocation.*

Faber, M. (2013). *A Quantitative Approach to Tactical Asset Allocation.*

Faber, M., & Richardson, E. (2009). *The Ivy Portfolio: How to Invest Like the Top Endowments and Avoid Bear Markets.*

Gorton, G., & Rouwenhorst, K. (2004). Facts and Fantasies about Commodity Futures. *Yale ICF Working Paper No. 04-20*.

Gray, W. (2016). *Alpha Architect - Even God Would Get Fired As An Active Investor*. Retrieved from http://blog.alphaarchitect.com/2016/02/02/even-god-would-get-fired-as-an-active-investor/

Greer, R. (1997). What is an Asset Class, Anyway? *The Journal of Portfolio Management, 23*, 86-91.

Greyserman, A., & Kaminski, K. (2014). *Trend Following with Managed Futures: The Search for Crisis Alpha.*

Ibbotson Associates. (2006). *Strategic Asset Allocation and Commodities.* PIMCO.

Ibbotson et all. (2016). *Stocks, Bonds, Bills and Inflation (SBBI) Yearbook.*

Ilmanen, A. (2011). *Expected Returns: An Investor's Guide to Harvesting Market Rewards.*

Irwin, S., & Sanders, D. (2010). *The Impact of Index and Swap Funds on Commodity Futures Markets: Preliminary Results.* OECD Food, Agriculture and Fisheries Working Papers, No. 27.

Jennings, W. W., & Payne, B. C. (2016). Fees Eat Diversification Lunch. *Financial Analysts Journal, 72*(2), 31-40.

Levine, A., Ooi, Y., & Richardson, M. (2016). Commodities for the Long Run.

Lombardi, M., & Ravazzolo, F. (2013). On the correlation between commodity and equity returns: implications for portfolio allocation. *Bank for International Settlements Working Papers, 420*.

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance, 7*(1), 77-91.

Martin, P. G., & McCann, B. B. (1989). *The Investor's Guide to Fidelity Funds.*

Morningstar. (2008). Return Calculation of U.S. Treasury Constant Maturity Indices.

Sandoval Jr, L., & Franca, I. (2010). *Correlation of financial markets in times of crisis.*

Silvennoinen, A., & Thorp, S. (2009). *Financialization, crisis and commodity correlation dynamics.*

Tversky, A., & Kahneman, D. (1971). Belief in the law of small numbers. *Psychological Bulletin, 76*, 105-110.

Zaremba, A. (2015). Portfolio Diversification with Commodities in Times of Financialization. *International Joural of Finance & Banking Studies, 4*(1), 18-36.

Faber, Meb (2006). A Quantitative Approach to Tactical Asset Allocation (working paper).

Statistical Mechanics and its Applications, 391, 1, p 187-208

Inker, B., (2020). “The Hidden Risks of Risk Parity Portfolios”, GMO White Paper

Friesen, G., Weller, P. and L. Dunham, (2009), “Price trends and patterns in technical analysis: A theoretical and empirical examination”, Journal of Banking & Finance, 33, 1089- 1100.

Clare, Andrew and Seaton, James and Smith, Peter N. and Thomas, Steve, The Trend is Our Friend: Risk Parity, Momentum and Trend Following in Global Asset Allocation (July 31st, 2015). Available at SSRN: https://ssrn.com/abstract=2126478 or http://dx.doi.org/10.2139/ssrn.2126478