A Quantitative Approach to Tactical Asset Allocation

Mebane T. Faber

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ABSTRACT

The purpose of this paper is to present a simple quantitative method that improves the risk-adjusted returns across various asset classes. The approach is examined since 1972 in an allocation framework utilizing a combination of publicly traded indices including the Standard and Poor's 500 Index (S&P 500), Morgan Stanley Capital International Developed Markets Index (MSCI EAFE), Goldman Sachs Commodity Index (GSCI), National Association of Real Estate Investment Trusts Index (NAREIT), and United States Government 10-Year Treasury Bonds. The empirical results are equity-like returns with bond-like volatility and drawdown, and over thirty consecutive years of positive returns.

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INTRODUCTION

Many global asset classes in the 20th Century produced spectacular gains in wealth for individuals who bought and held those assets for generational long holding periods. However, most of the common asset classes experienced painful drawdowns, while others complete elimination of wealth. Indeed, many investors can recall the horrific 40-80% declines they faced in the aftermath of the global equity market collapse only a few years ago. The United States has been rather unique in that its equity and bond markets have operated continuously throughout the previous century. Many stock and bond markets across the globe have seen complete elimination of wealth – a 100% drawdown[1] and loss of all capital. Individuals unlucky to be invested in US stocks in the late 1920s and early 1930s, any German asset class in the 1910s and 1940s, US Real Estate in the mid 1950s, Japanese stocks in the late 1980s, and emerging markets and commodities in the late 1990s (to name a few) would reason that owning these assets was decidedly not the best course of action.

Modern portfolio theory postulates that the volatility and drawdowns associated with the aforementioned capital markets is the tradeoff an investor must accept to achieve corresponding levels of return. Table 1 presents the risk and return figures for the five asset classes that will be examined in this paper since 1972, and all five experienced rather significant drawdowns.

Table 1 – Asset class total returns since 1972

	S&P 500	EAFE	10Yr Bond	GSCI	NAREIT
CAGR	11.24%	11.34%	8.35%	12.03%	10.60%
Stdev	17.47%	22.19%	11.24%	24.58%	20.21%
Sharpe	0.41	0.33	0.39	0.33	0.33
MaxDD	(44.73%)	(47.47%)	(18.79%)	(48.25%)	(58.10%)
Best Year	37.58%	69.94%	44.28%	74.96%	48.97%
Worst Year	(26.47%)	(23.20%)	(7.51%)	(35.75%)	(42.23%)

This paper will present a quantitative approach that improves risk-adjusted returns in every asset class tested. The methodology will utilize asset classes including the Standard and Poor's 500 Index (S&P 500), Morgan Stanley Capital International Developed Markets Index (MSCI EAFE), Goldman Sachs Commodity Index (GSCI), National Association of Real Estate Investment Trusts Index (NAREIT), and United States Government 10-Year Treasury Bonds.[2] It will then go on to examine the approach in an asset allocation framework, including historical and leveraged results of the strategy.

THE QUANTITATIVE SYSTEM

In deciding on what logic to base this system on, there are a few criteria that are necessary for this to be a simple model that investors can follow, and mechanical enough to remove all emotion and decision-making. They are:

1. Simple, non-optimized, purely mechanical logic.
2. The same model and parameters for every asset class.
3. Price-based only.

[1] Drawdown is the peak-to-trough decline an investor would experience in an investment, and we calculate it here on a monthly basis.
[2] For descriptions of data sources and asset classes utilized in this paper, refer to Appendix A. All data are total return series, and are updated monthly.

The most often cited long-term measure of trend in the technical analysis community is the 200-Day Simple Moving Average. In his book "Stocks for the Long Run", Jeremy Siegel (2002) investigates the use of the 200-day SMA in timing the Dow Jones Industrial Average since 1900, and concludes that market timing improves the absolute and risk-adjusted returns over a buy-and-hold of the DJIA. Likewise, when all transaction costs are included (taxes, bid-ask spread, commissions), the risk-adjusted return is still higher when market timing, though timing falls short on an absolute return measure. When applied to the Nasdaq Composite since 1972, the market timing system thoroughly out-performs the buy-and hold, both on an absolute and risk-adjusted basis. (Note: Sigel's system is three times as active as the system presented in this article, thus increasing the transaction costs). We will use the monthly equivalent of Siegle's 200-Day SMA – the 10-Month SMA.

The system is as follows:

BUY RULE

Buy when monthly price > 10-month SMA.

SELL RULE

Sell and move to cash when monthly price < 10-month SMA.

1. All entry and exit prices are on the day of the signal at the close.
2. All data series are total return series including dividends, updated monthly.
3. Cash returns are estimated with 90-day commercial paper, and margin rates (for leveraged models to be discussed later) are estimated with the broker call rate.
4. Taxes, commissions, and slippage are excluded (see "practical considerations" section later in the paper).

S&P 500 BACK TO 1900

To demonstrate the logic and characteristics of the timing system, we test the S&P 500 back to 1900[3]. Table 2 on the following page presents the yearly returns for the S&P 500 and the timing method for the past 100+ years. A cursory glance at the results reveals that the timing solution improved return (CAGR), while reducing risk (standard deviation, drawdown, worst year, Ulcer Index[4]), all while being invested in the market approximately 70% of the time, and making less than one round trip trade per year.

The timing system achieves these superior results while under-performing the index in roughly 40% of the years since 1900. One of the reasons for the overall out-performance is the lower volatility of the timing system, due to high volatility diminishing compound returns. This fact can be illustrated by comparing average returns with compounded returns (the returns an investor would actually realize.) The average return for the S&P 500 since 1900 was 11.66%, while timing the S&P 500 returned 11.72%. However, the compounded returns for the two are 9.75% and 10.66%, respectively. Notice that the buy-and-hold crowd takes a 191 basis point hit from the effects of volatility, while timing suffers a smaller, 106 basis point decline. Ed Easterling (2006) has a good discussion of these "volatility gremlins" in John Mauldin's Book, "Just One Thing".

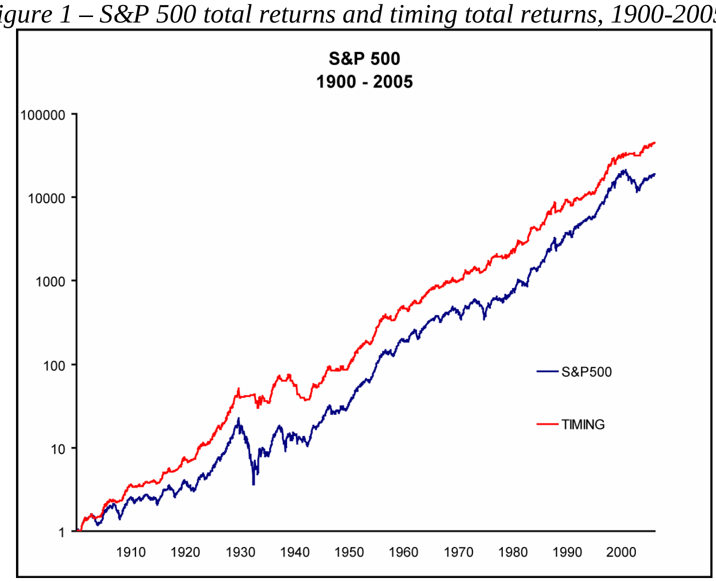
[3] The S&P 500 Total Return Index is based upon calculations by Global Financial Data before 1971.
[4] The Ulcer Index (UI) takes into account depth and duration of drawdowns from recent peaks, and is a measure of downside volatility. A lower number is more desirable, and for a formula description see Appendix B. The Sharpe ratio is a measure of excess returns versus volatility in general, and it uses yearly returns and 4% as the risk free rate. CAGR – Compounded annual growth rate, Stdev – Standard deviation, MaxDD – Maximum drawdown, Mar Ratio – absolute value of (CAGR / MaxDD),

Table 2 – S&P 500 total returns and timing total returns, 1900-2005

	SP500	TIMING
CAGR	9.75%	10.66%
Stdev	19.91%	15.38%
Sharpe	0.29	0.43
MaxDD	(83.66%)	(49.98%)
MAR Ratio	0.14	0.23
UlcerIndex	20.33%	11.70%
%TimeinMkt	100.00%	69.77%
RT Trades/Year	-	0.67
% + Trades	-	63%
Best Year	52.88%	52.40%
Worst Year	(43.86%)	(26.69%)

It is easy to see that the timing is superior over the past century on Figure 1 (logarithmic scale), largely avoiding the significant bear markets of the 1930s and 2000s. Timing would not have left the investor completely unscathed from the late 1920s early 1930s bear market, but it would have reduced the drawdown from a catastrophic -83.66% to -42.24%.

Figure 1 – S&P 500 total returns and timing total returns, 1900-2005



A glance at Table 3 below presents the top ten worst years for the S&P 500 for the past century, and the corresponding returns for the timing system. It is immediately obvious that the two do not move in lockstep. In fact, the correlation between negative years on the S&P 500 and the timing model is approximately -.37, while the correlation for all years is approximately .82.

Table 3 – S&P 500 10 Worst Years vs. Timing

		S&P 500	TIMING
WORST 10	**1931**	(43.86%)	2.49%
Years	**1937**	(35.26%)	(7.37%)
	1907	(29.61%)	(0.50%)
	1974	(26.47%)	9.73%
	1917	(25.26%)	(3.33%)
	1930	(25.26%)	3.29%
	2002	(22.10%)	(4.73%)
	1920	(19.69%)	(3.50%)
	1973	(14.69%)	(15.02%)
	1903	(14.65%)	0.19%

Figure 2 – S&P 500 excess returns (rm – rf) vs. timing excess returns (rt-rf), 1900-2005

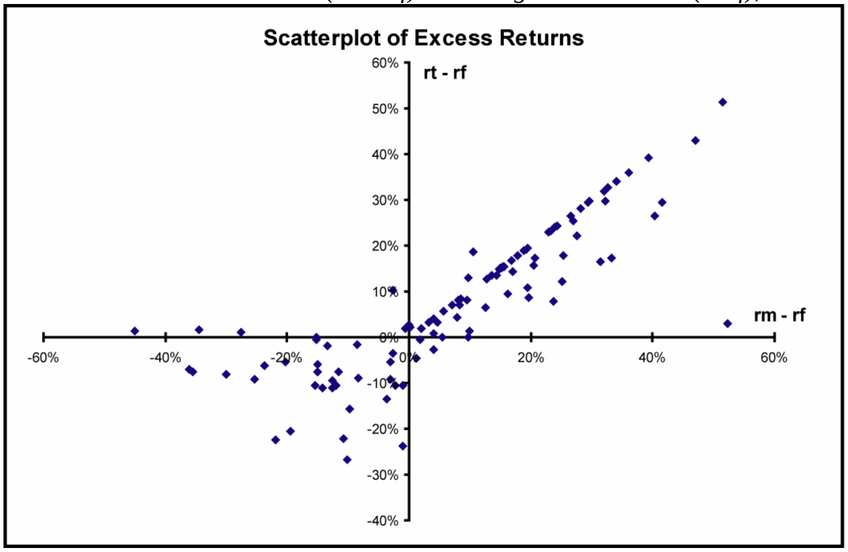
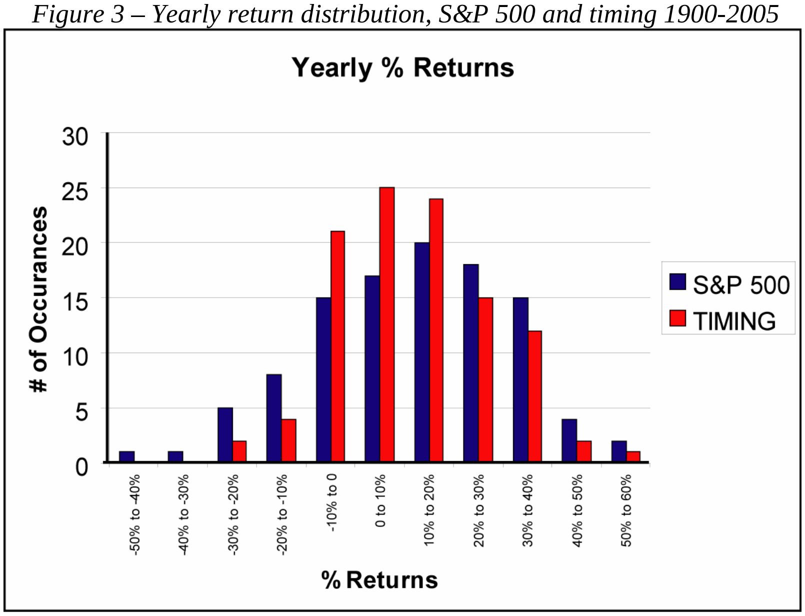


Figure 2 above is the excess returns (over money market rates, rt - rf) generated by the timing system versus excess returns of buy-and-hold (rm – rf). Just from the graph, it can be inferred that there exists a linear relationship for positive returns, while the negative returns are much more scattered. Appendix B discusses the results using the Treynor Mazuy and Henriksson Merton equations, both of which show evidence for market timing ability.

Figure 3 gives a good pictorial description of the results of the trend following system applied to the S&P 500. The timing system has fewer occurrences of both large gains and large losses, with correspondingly higher occurrences of small gains and losses. Essentially the system is a mean-reversion model that signals when an investor should be long a riskier asset class with potential upside, and when to be out and sitting in cash. It is this move to a lower volatility asset class (cash) that drops the overall risk and drawdown of the portfolio.

Figure 3 – Yearly return distribution, S&P 500 and timing 1900-2005



As a check against optimization, and to show that using the 10-month SMA is not a unique solution, Table 4 below presents the stability of using various parameters. Calculation periods will perform differently in the future as cyclical and secular forces drive the return series, but all of the parameters below seem to work similarly for a long-term trend following application.

Table 4 – S&P 500 vs. various moving average timing lengths.

	S&P 500	6 month	8 month	10 month	12 month	14 month
CAGR	9.75%	10.02%	10.60%	10.66%	**10.80%**	10.55%
Stdev	19.91%	**15.08%**	15.37%	15.37%	15.57%	15.81%
Sharpe	0.29	0.40	0.43	0.43	**0.44**	0.41
MaxDD	-83.66%	**-44.65%**	-56.09%	-49.98%	-47.74%	-51.35%
MAR	0.14	**0.25**	0.21	0.23	**0.25**	0.23
%TimeinMkt	100%	69.00%	70.00%	70.00%	71.00%	72.00%
UlcerIndex	20.33%	**11.55%**	13.35%	11.70%	11.76%	12.86%

The grey boxes highlight the best performing moving average length for each return and risk statistic. The 10-month SMA is not the optimum parameter for any of the statistics, but it is evident that there is very broad parameter stability across the five moving average lengths.

SYSTEMATIC TACTICAL ASSET ALLOCATION

The results of a stable model should translate to all asset classes. Five diverse asset classes were chosen including US stocks (S&P 500), foreign stocks (MSCI EAFE), US bonds (10 Year Treasuries), commodities (GSCI), and real estate (NAREIT). Table 5 presents the results for each asset class, and the respective timing results.

Table 5 – Asset class total returns vs. timing total returns, 1972-2005

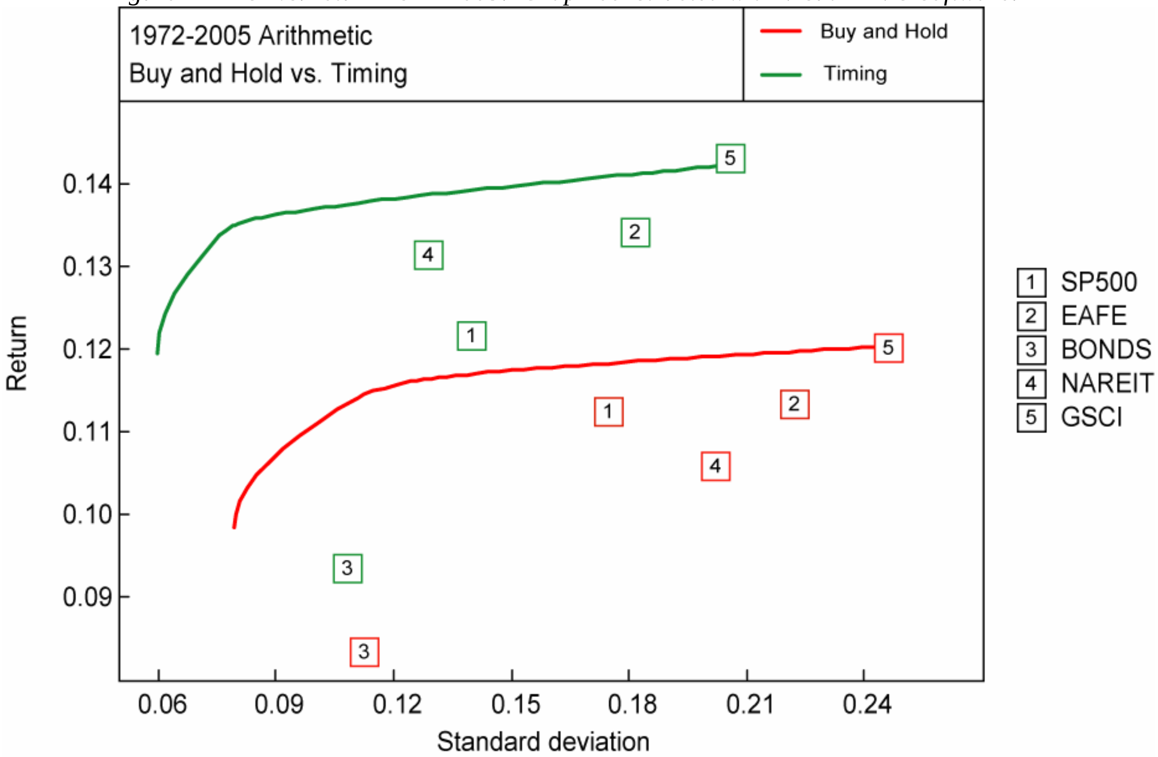
	SP500	TIMING	EAFE	TIMING	10Yr Bond	TIMING	GSCI	TIMING	NAREIT	TIMING	
CAGR	11.24%	11.18%	11.34%	12.02%	8.35%	8.73%	12.03%	12.46%	10.60%	12.33%	
Stdev	17.47%	14.00%	22.19%	18.17%	11.24%	10.87%	24.58%	20.44%	20.21%	12.92%	
Sharpe	0.41	0.51	0.33	0.44	0.39	0.44	0.33	0.41	0.33	0.64	
MaxDD	(44.73%)	(23.26%)	(47.47%)	(23.23%)	(18.79%)	(11.18%)	(48.25%)	(37.98%)	(58.10%)	(16.42%)	
MAR	0.25	0.48	0.24	0.52	0.44	0.78	0.25	0.33	0.18	0.75	
UlcerIndex	12.85%	6.30%	15.00%	7.48%	4.13%	3.29%	16.64%	13.92%	13.93%	4.43%	
Best Year	37.58%	37.58%	69.94%	69.94%	44.28%	44.28%	74.96%	74.96%	48.97%	48.97%	
Worst Year	(26.47%)	(15.02%)	(23.20%)	(13.74%)	(7.51%)	(4.96%)	(35.75%)	(21.98%)	(42.23%)	(14.34%)	Averages
%TimeinMkt	-	75.79%	-	72.13%	-	77.26%	-	69.44%	-	74.02%	73.73%
RT Trades/Year	-	0.59	-	0.71	-	0.76	-	0.79	-	0.62	0.69
% + Trades	-	63.00%	-	56.00%	-	52.00%	-	44.00%	-	59.00%	54.80%
Avg win trade	-	25.35%	-	27.22%	-	17.96%	-	38.90%	-	30.02%	27.89%
Avg win trade length	-	19.20	-	16.53	-	20.92	-	20.27	-	20.46	19.48
Avg lose trade	-	(5.06%)	-	(5.17%)	-	(1.91%)	-	(3.67%)	-	(3.66%)	(3.90%)
Avg lose trade length	-	1.89	-	3.42	-	3.17	-	3.4	-	4.11	3.20

While timing model returns are approximately the same as each asset class (although higher in four of the five), risk was reduced in every case across every measure – standard deviation, maximum drawdown, Ulcer Index, and worst year. Better yet, the results and trading statistics were consistent across the five asset classes.

In addition the average winning trade was seven times larger than the average losing trade, and the length in winners was six times larger than the length of losing trades. Percent winning trades across the five asset classes was at an uncharacteristically high (for trend following systems) 54.8%.

Figure 4 below presents the risk vs. arithmetic returns graph for the asset classes and the timing models. In every case the market timing model shifted the position of an asset class left and in most cases up as well.

Figure 4 – Risk vs. return 1972-2005. Graph constructed with Visual MVO software.



Given the ability of this very simplistic market timing rule to add value to various asset classes, it is instructive to examine how the returns would look in the context of an investor's portfolio. The returns for a buy-and-hold allocation are referenced as asset allocation (AA), and are equally weighted across the five asset classes. Weightings are rebalanced monthly, although tests we conducted show that yearly rebalancing of weightings gives near identical results. The timing model treats each asset class independently – it is either long the asset class or in cash with its 20% allocation of the funds. Table 6 below illustrates the percentage of months in which various numbers of assets were held. It is evident that the system keeps the investor 60-100% invested the vast majority of the time.

Table 6 – Number of positions and their frequency

# of Positions	# of Months	% of Months
0 (all cash)	4	0.98%
1	18	4.41%
2	46	11.27%
3	88	21.57%
4	150	36.76%
5 (100% invested)	102	25.00%
Total	408	100.00%

Table 7 below presents the results for the buy and hold of the five asset classes equal-weighted (AA) vs. the timing portfolio. The buy-and-hold returns are quite respectable on a stand-alone basis, and present evidence of the benefits of diversification. The timing results in a reduction in volatility to single-digit levels, as well as single-digit drawdown. The Ulcer Index gets cut in half, and the investor would not have experienced a down year since inception in 1972.

Table 7 – Asset allocation buy-and-hold vs. asset allocation timing, 1972-2005

	AA	TIMING		AA	TIMING
1972	21.92%	21.11%	1989	19.25%	18.15%
1973	1.03%	7.67%	1990	(1.10%)	4.92%
1974	(11.80%)	13.35%	1991	18.19%	6.33%
1975	20.16%	1.40%	1992	3.88%	4.73%
1976	15.04%	15.95%	1993	11.90%	12.81%
1977	8.24%	7.17%	1994	1.76%	2.49%
1978	13.65%	11.94%	1995	22.74%	21.72%
1979	17.89%	14.63%	1996	19.32%	19.26%
1980	18.95%	12.69%	1997	9.96%	9.94%
1981	(3.34%)	4.57%	1998	(0.49%)	7.44%
1982	21.34%	22.10%	1999	14.16%	13.12%
1983	17.97%	15.74%	2000	12.73%	13.76%
1984	9.43%	6.92%	2001	(9.74%)	3.10%
1985	26.58%	26.17%	2002	2.09%	3.33%
1986	25.50%	21.52%	2003	25.70%	20.52%
1987	8.53%	11.86%	2004	17.44%	15.08%
1988	18.46%	11.83%	2005	11.74%	8.21%

	AA	TIMING	S&P 500	10Yr Bond
CAGR	11.57%	11.92%	11.24%	8.35%
Stdev	10.04%	6.61%	17.47%	11.24%
Sharpe	0.75	1.20	0.41	0.39
MaxDD	(19.62%)	(9.51%)	(44.73%)	(18.79%)
MAR	0.59	1.25	0.25	0.44
UlcerIndex	4.04%	1.70%	12.85%	4.13%
Best Year	26.58%	26.17%	37.58%	44.28%
Worst Year	(11.80%)	1.40%	(26.47%)	(7.51%)

An obvious extension of this approach is to apply leverage to generate excess returns to the non-leveraged portfolio. Table 8 adds a column for the 2X levered portfolio.

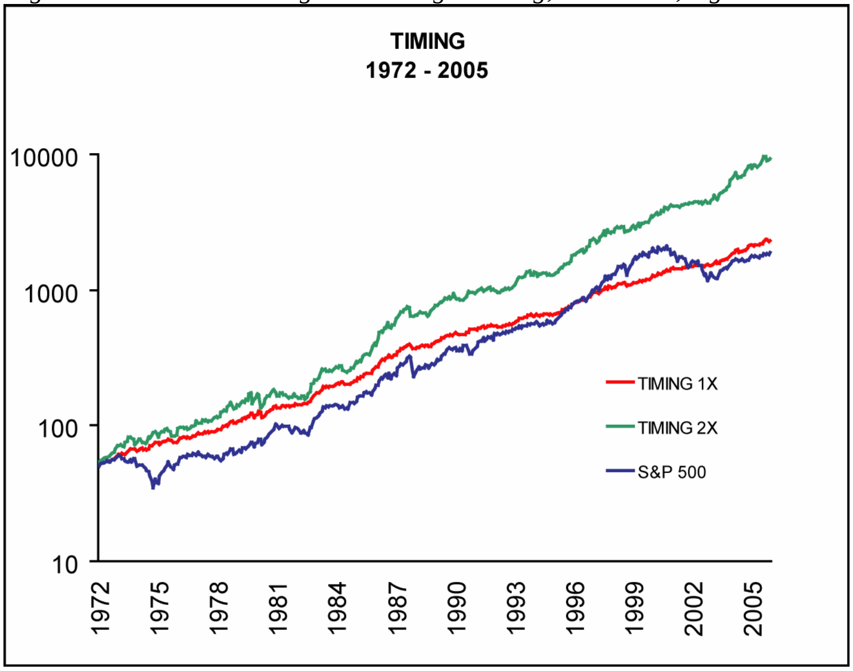
Table 8 – Asset allocation vs. timing and leveraged timing, 1972-2005

	AA	TIMING	TIMING 2X
CAGR	11.57%	11.92%	16.56%
Stdev	10.04%	6.61%	13.88%
Sharpe	0.75	1.20	0.90
MaxDD	(19.62%)	(9.51%)	(21.87%)
MAR	0.59	1.25	0.76
UlcerIndex	4.04%	1.70%	5.10%
Best Year	26.58%	26.17%	46.42%
Worst Year	(11.80%)	1.40%	(5.51%)

The first noticeable observation is that the 2X model does not produce 2X returns, and this is due to the fact the investor must borrow funds to finance his leverage[5]. The 2X levered portfolio produces very similar risk statistics as buy-and-hold, but adds approximately 500 basis points to the return. Figure 5 below illustrates the equity curves for the S&P 500, Timing, and 2X leveraged portfolios.

[5] Margin rates are estimated with the broker call rate.

Figure 5 S&P 500 vs. timing and leveraged timing, 1972-2005, log scale



PRACTICAL CONSIDERATIONS

There are a few practical considerations an investor must analyze before implementing these models for real world applicability – namely management fees, taxes, commissions, and slippage.

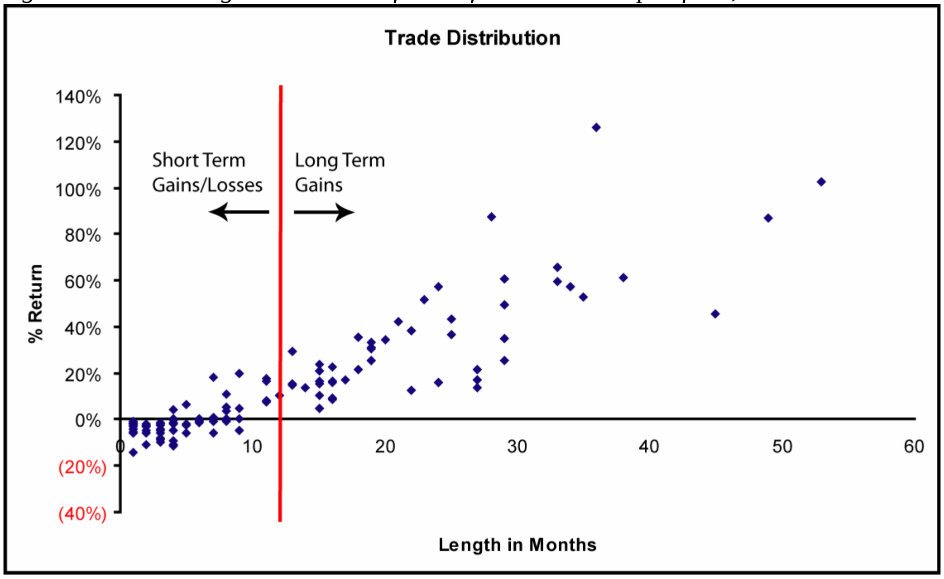
Management fees should be identical for the buy-and-hold and timing models, and will vary depending on the instrument used for investing. 20-100 basis points is a fair estimate for these fees using ETFs and no-load mutual funds.

Commissions should be a near negligible factor due to the low turnover of the models. On average, the investor would be making 3-4 round trip trades per year for the entire portfolio, and less than one round-trip trade per asset class per year. Slippage likewise should be near negligible, as there are numerous mutual funds (0 slippage) as well as liquid ETFs an investor can choose from.

Taxes, on the other hand, are a very real consideration. Due to the various capital gains rates for different investors (as well as varying tax rates across time, as well as for dividends) it is difficult to estimate the hit an investor would suffer from trading this system. The obvious solution for individuals is to trade the system in a tax-deferred account such as an IRA. Many institutions enjoy tax-exempt status as well.

There is one bright note however for those who have to trade this model in a taxable account. The nature of the system results in a high number of short-term capital gains losses, and a large percentage of long-term capital gains. Figure 6 depicts the distribution for all the trades for the five asset classes since 1972. This should help reduce the tax burden for the investor.

Figure 6 – Trade length distribution for the five asset-class portfolio, 1972-2005.



CONCLUSION

The intent of this paper is to create a simple-to-follow method for managing risk for an asset class, and consequently, a portfolio of assets. Utilizing a monthly system since 1972, an investor would have been able to increase his risk-adjusted returns by diversifying his assets and employing a market timing solution. The investor would have also been able to side-step many of the protracted bear markets in various asset classes. Avoiding these massive losses would have resulted in equity-like returns with bond-like volatility and drawdown. These results compare favorably with various measures of hedge fund index performance.

I would like to conclude with a final quote. In Reminiscences of a Stock Operator, Jessie Livermore states, "A loss never bothers me after I take it. I forget it overnight. But being wrong – not taking the loss – that is what does damage to the pocketbook and to the soul."

APPENDIX A – Data and Indices

S&P 500 Index – A capitalization-weighted index of 500 stocks that is designed to mirror the performance of the United States economy. Total return series is provided by Global Financial Data and results pre-1971 are constructed by GFD. Data from 1900-1971 uses the S&P Composite Price Index and dividend yields supplied by Cowles Commission and from S&P itself.

MSCI Developed Market Index (EAFE) – A market-capitalization-weighted index that is comprised of 20 countries outside of North America. Total return series is provided by Morgan Stanley.

US Government 10-Year Bonds – Total return series is provided by Global Financial Data.

Goldman Sachs Commodity Index (GSCI) – Represents a diversified basket of commodity futures that is unlevered and long only. The returns include the collateral yield an investor would receive if invested in the index. Total return series is provided by Goldman Sachs.

National Association of Real Estate Investment Trusts (NAREIT) – An index that reflects the performance of publicly traded REITs. Total return series is provided by the NAREIT.

VisualMVO Software **-** Single period mean-variance optimizer designed by Efficient Solutions, Inc.

APPENDIX B - Formulas & Market Timing Equations

The Ulcer Index was developed by Peter G. Martin and Byron B. McCann, and detailed in their book, "The Investor's Guide To Fidelity Funds" (1989).

It takes into account depth and duration of drawdowns from recent peaks, and is a measure of downside volatility.

UI = square root [the sum of all R^2 values/N)
Where: R = the percent a fund is below its highest previous value
N = the number of measurements (days, months) in the period.

Treynor and Mazuy proposed this squared regression model in 1966

$$rp - rf = a + b\{rm - rf\} + g\{rm - rf\}^2 + e$$

r(p)... return series
rf... risk free rate (a constant)
a... alpha
b... beta
e... noise
g... market timing coefficient

The variable gamma will measure timing capabilities: A positive gamma will indicate that timing activities have added value to portfolio performance. Comparing the gammas of different funds will indicate the relative importance of timing activities in their investment policies.

Gamma for the Timing vs. S&P 500 since 1900 was 1.25 (a figure above 0 is evidence of positive market timing ability).

Henriksson and Merton proposed this simpler model in 1982

$$r(p) - rf = a + b\{rm - rf\} + g\{rm - rf\}D + e$$

r(p)... return series
rf... risk free rate (a constant)
a... alpha
b... beta
D…dummy variable =1 for rm > rf and 0 otherwise
e... noise
g... market timing coefficient

Gamma for the Timing vs. S&P 500 since 1900 was 0.77 (a figure above 0 is evidence of positive market timing ability).

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