A Quantitative Approach to Tactical Asset Allocation

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ABSTRACT

In this paper we update our 2006 white paper "A Quantitative Approach to Tactical Asset Allocation" with new data from the 2008-2012 period. How well did the purpose of the original paper - to present a simple quantitative method that improves the risk-adjusted returns across various asset classes – hold up since publication? Overall, we find that the models have performed well in real-time, achieving equity like returns with bond like volatility and drawdowns. We also examine the effects of departures from the original system including adding more asset classes, introducing various portfolio allocations, and implementing alternative cash management strategies.

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The original version of this paper was published in 2006, with an update in 2009.

Updates included in the 2013 paper include:

1. Results are extended to include the years 2009-2012.
2. Additional asset classes are included.
3. Alternative cash management strategies are included.
4. Additional conservative and aggressive approaches are included.
5. Alternative allocations are included.
6. References translated into hyperlinks.

INVESTING IN RISKY ASSETS

Much has happened in the world since the original publication of this white paper in 2006. However, change has always been the constant, and indeed has anything new really been seen in our world of investing? Bubbles, defaults, government interventions, bear markets, downgrades, quantitative easing, fortunes made and lost – they've all happened before. (For a lengthy examination of bubbles, see our paper "Learning to Love Investment Bubbles".)

Since publication of the original paper we have seen a devastating bear market in 2008 – 2009. The normal benefits of diversification disappeared as many non-correlated asset classes experienced large declines simultaneously. Commodities, REITs, and foreign stock indices all suffered drawdowns over 50%. (Drawdown is the peak-to-trough decline an investor would experience in an investment, and we calculate it here on a monthly basis.) The classic barometer of stocks, the S&P 500 Index, declined 36.77% in 2008 alone.

The fantastic book ***Triumph of the Optimists: 101 Years of Global Investment Returns*** (and **2012 update here**), illustrates that many global asset classes in the twentieth century produced spectacular gains in wealth for individuals who bought and held those assets for generation-long holding periods, but the assets also went through regular and painful drawdowns like 2008. All of the G-7 countries have experienced at least one period where stocks lost 75% of their value. The unfortunate mathematics of a 75% decline

require an investor to realize a 300% gain just to get back to even – the equivalent of compounding at 10% for 15 years!

For some long term perspective, below are some long term charts based on the data from Morningstar / Dimson Marsh Staunton. Below are the best, middle, and worst case scenarios for the main asset classes of sixteen countries from 1900-2011. All are real return series on a log graph (except the last one).

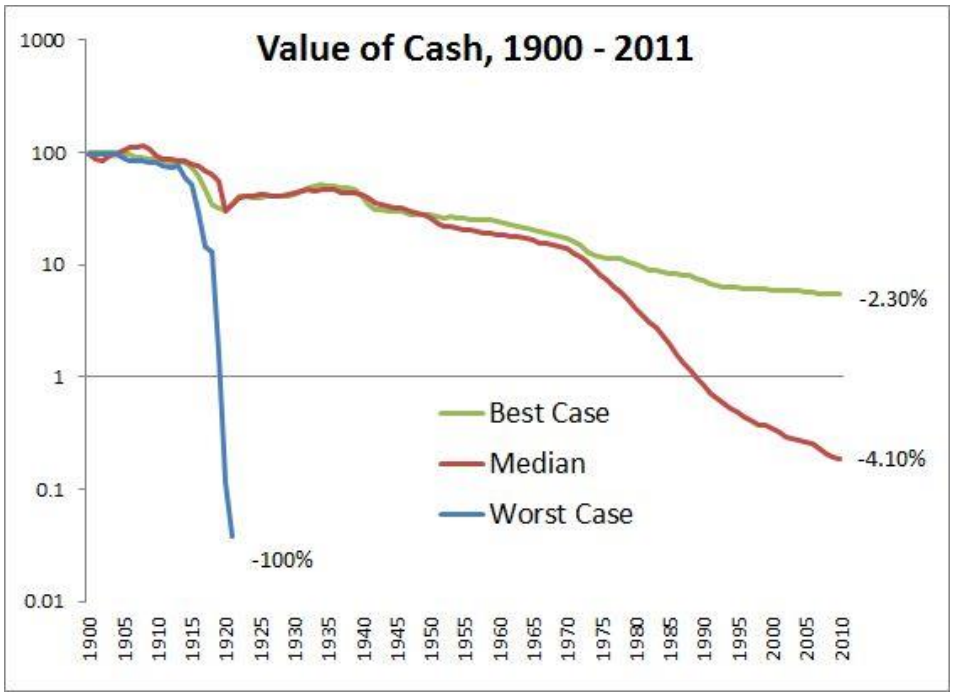
First, here are the best cases for returns on your cash. This chart goes to show that leaving cash under your mattress is a slow bleed for a portfolio. Germany is excluded after the first series as it dominates the worst case scenarios (in this case hyperinflation).

Chart 1 – Cash Real Returns, 1900-2011

Best Case: -2.30% per year

Middle: -4.10%

Worst Case: -100%



Next up is real returns for short term government bills.

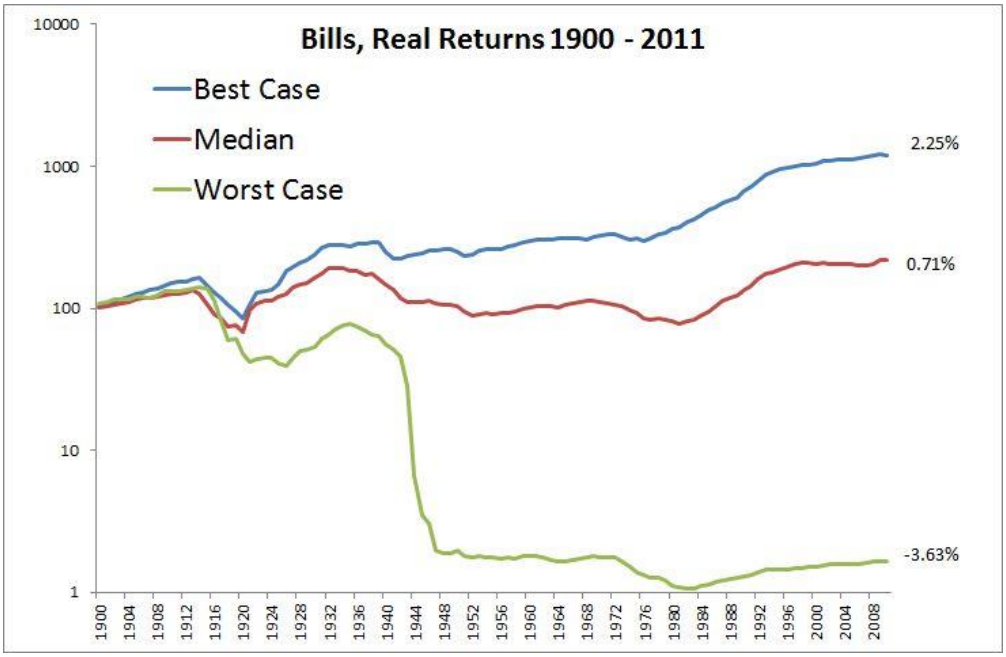
Chart 2 –Short Term Government Bills Real Returns, 1900-2011

Best Case: 2.25% per year

Middle: 0.71%

Worst Case: -3.63%

(Real Worst Case, Germany -100%)



Followed by the real returns for longer dated bonds:

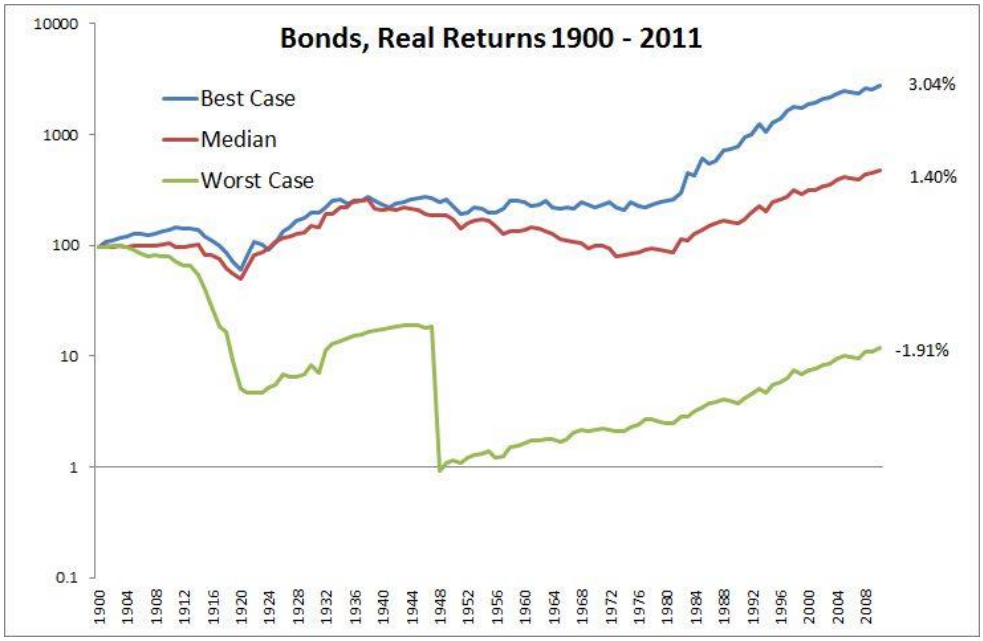
Chart 3 –Long Term Government Bonds Real Returns, 1900-2011

Best Case: 3.04% per year

Middle: 1.40%

Worst Case: -1.91%

(Real Worst Case, Germany -100%)



And finally, the real returns for equities.

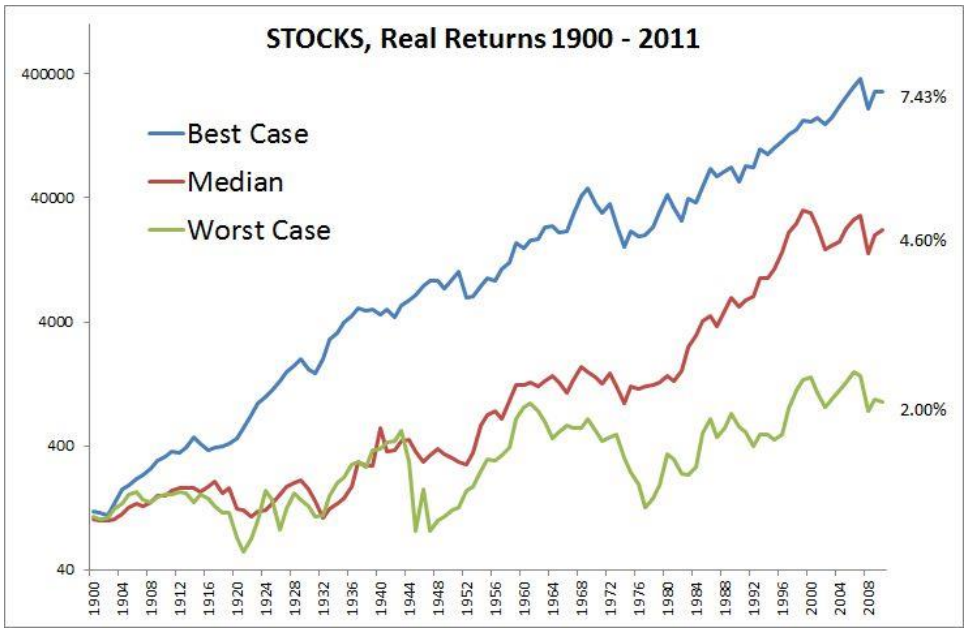
Chart 4 –Stocks Real Returns, 1900-2011

Best Case: 7.43% per year

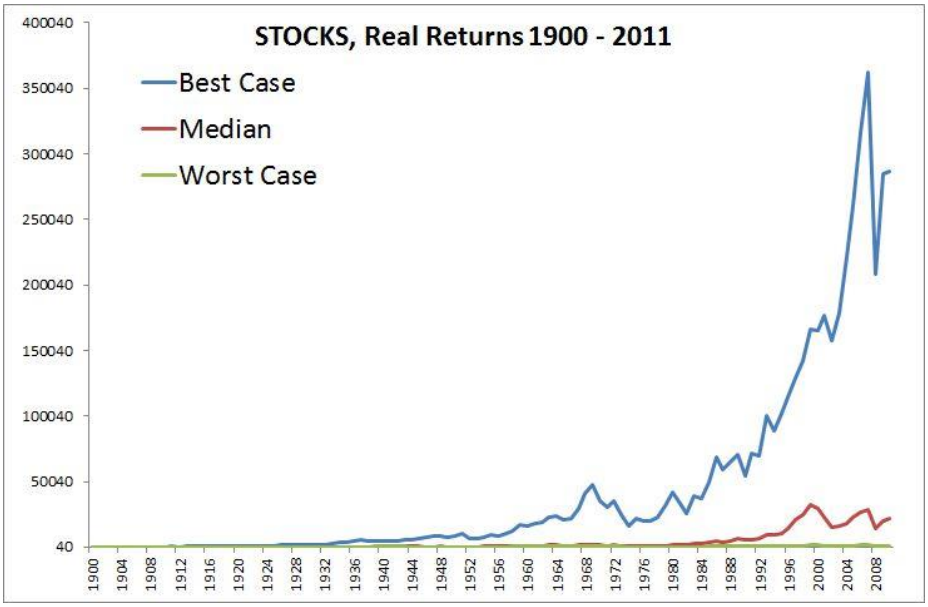
Middle: 4.60%

Worst Case: 2.00%

(Real Worst Case, China, Russia -100%)



And the same chart presented non-log...



Individuals invested in U.S. stocks in the late 1920s and early 1930s, German asset classes in the 1910s and 1940s, Russian stocks in 1927, Chinese stocks in 1949, U.S. real estate in the mid-1950s, Japanese stocks in the 1980s, emerging markets and commodities in the late 1990s, and nearly everything in 2008, would reason that holding these assets was a decidedly unwise course of action. Most individuals do not have a sufficiently long time frame to recover from large drawdowns from risky asset classes.

However, also since the recent update of this paper in 2009, we have seen a strong recovery in many of the world markets. While some markets are still down considerably from their peak values, here in the US stocks and bonds are trading near or at all-time highs including dividends.

Most importantly for any investor is that they have a plan and process for investing in any environment, regardless of how improbable or unfathomable that may be. Are you prepared for all of the possible outcomes, such as declines of 50-100% in your asset class or portfolio? Are you prepared for currency devaluations, but also massive rallies in stocks or bonds? Can you fathom a world with interest rates at 0.1% as well as at 10%?

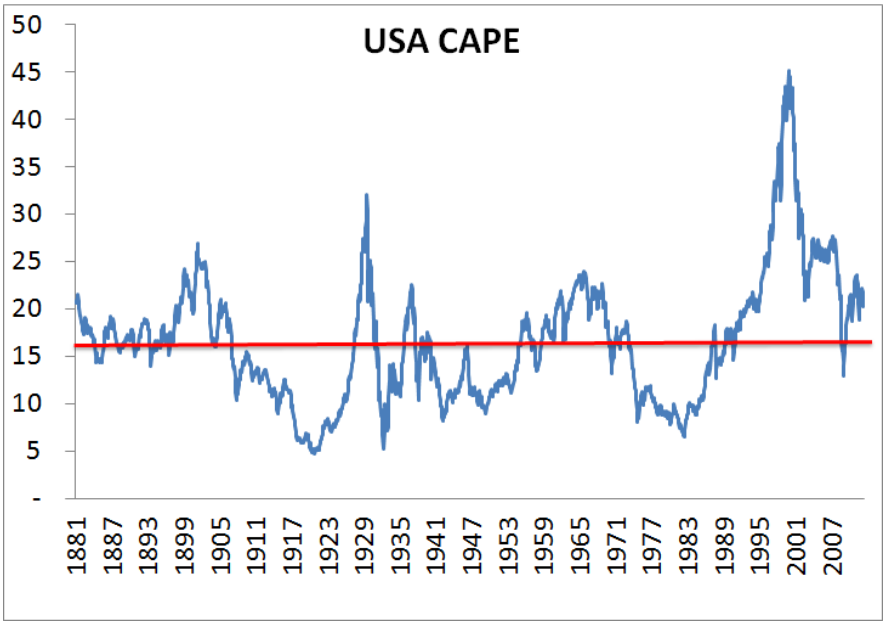
THE CURRENT CHALLENGE

While investors have benefitted from strong equity markets in 2012 with the S&P 500 up approximately 16%, the new millennium has been challenging for most investors.

US stocks have returned a meager 1.65% per year from 2000 – 2012, and factoring in inflation, have returned -0.76% per year. That is, if the investors had the ability to sit through two gut-wrenching bear markets with declines of over 45%, and according to recent DALBAR studies, many have not. The average equity investor underperformed the S&P 500 by 7.85% in 2011, and underperformed the index by 4.32% over the past 20 years. (Bond investors are equally as bad.)

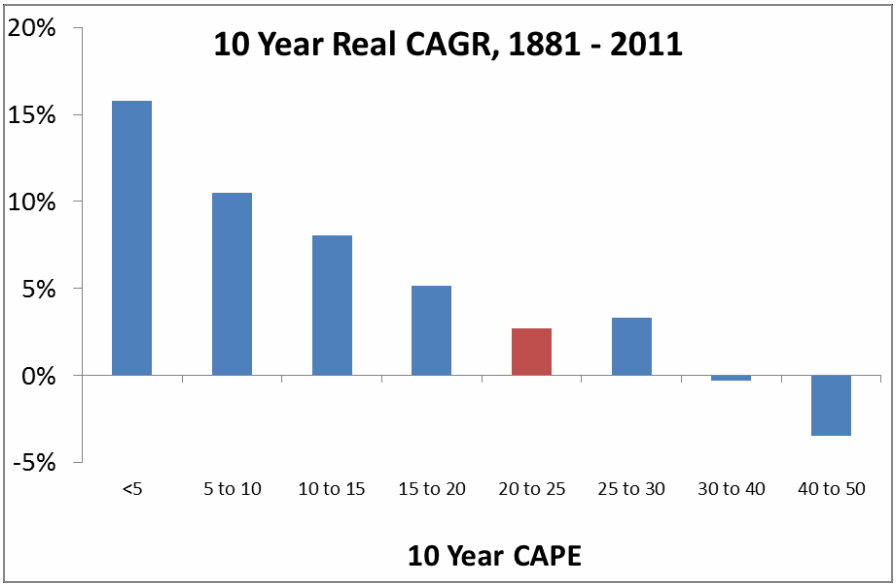
One of the reasons for the subpar returns is simple – valuations started the 2000s at extreme levels. The ten-year cyclically adjusted price-to-earnings ratio (CAPE) reached a level of 45 in December 1999, the highest level ever recorded in the US. (We examine approximately 40 global stock markets and how to use global CAPEs in our paper "Global Value: Building Trading Models with the 10 Year CAPE".)

Figure 1 – Ten-Year Cyclically Adjusted Price-To-Earnings Ratio (CAPE), 1881-2011



As you can see in the figure below, future returns are highly dependent on starting valuations. The current reading as of the end of 2012 is 21.55, about 30% above the long-term average of around 16.5. At the current levels of 20-25, future returns have been an uninspiring 6% nominal, and 3% real since 1881. Not horrific, but not that exciting either.

Figure 2 – Ten-Year CAPE vs. Future Returns, 1881-2011



US government bonds on the other hand proved to be a wonderful place to invest during the past twelve years. The compound return was 7.07% and a nice 4.5% after inflation. The problem with these returns, however, is that they come at the expense of future returns as yields have declined to all time low levels in the US below 2%.

Future bond returns are fairly easy to forecast - it is simply the starting yield. Your ten-year nominal return for buying US government bonds will be around 2% currently if held to maturity.

So, investors are presented with the following opportunity set (assuming 3% inflation going forward, and rounding to make it simple):

US stocks: 6% nominal, 3% real

US Bonds: 2% nominal, -1% real

That leaves a 60/40 investor with a 4.4% nominal return, or a 1.4% real return. Not exactly exciting!

So where should investors look for outsized returns while managing their risk? We examine the effects of expanding a traditional 60/40 allocation into a more global allocation in the coming pages. We then overlay some simple risk management in hopes of protecting a portfolio against brutal bear markets.

STEP 1 – GO GLOBAL

Modern portfolio theory holds that there is a tradeoff for investing in assets – you get paid to assume risk. Figure 3 shows the five asset classes that we will examine in this paper and their returns since 1973 (later in the paper we expand the study to include more asset classes.)

Unless otherwise noted all data series are total return series including dividends and income, and from Global Financial Data:

US Large Cap, S&P 500

Foreign Developed, MSCI EAFE

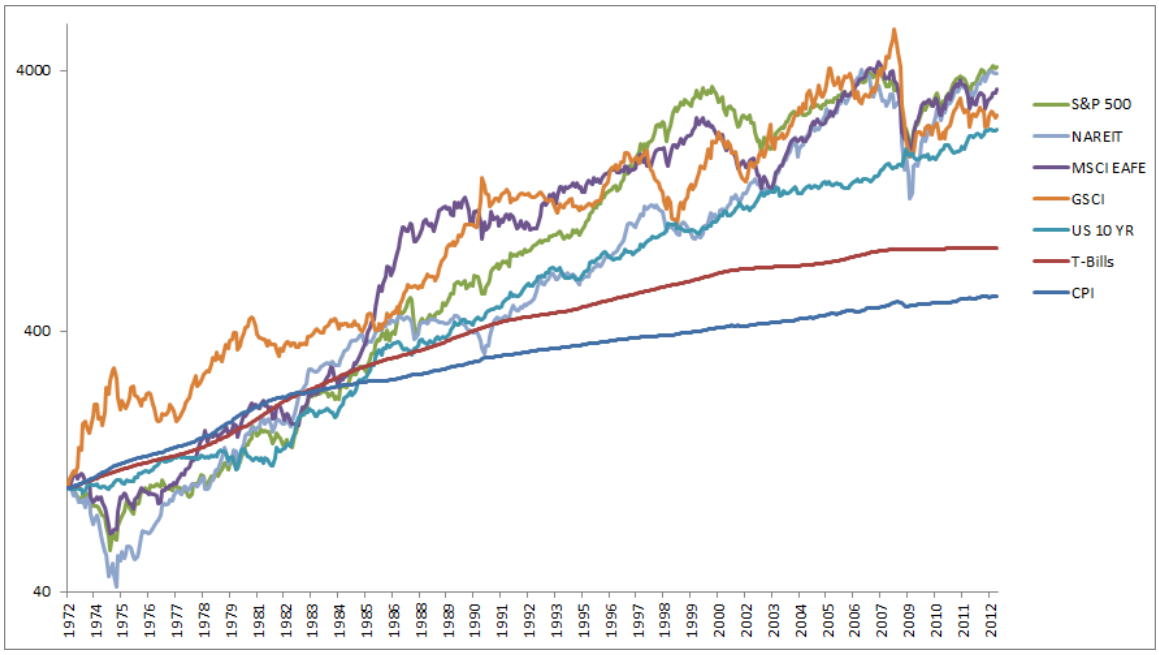
US 10-Year Government Bonds

Commodities, Goldman Sachs Commodity Index

Real Estate Investment Trusts, NAREIT Index

While the indexes traveled different routes from start to finish, most of the asset classes finished with similar returns over the time period. The exception was bonds, which trailed the other asset classes, an outcome that is to be expected due to their lower volatility and risk. The fact that bonds were even close in absolute performance to the other equity-like asset classes reflects the greater than twenty year bull market that took yields from double-digit levels to near 2% today.

Figure 3 - Asset Class Returns 1973-2012, Log Scale



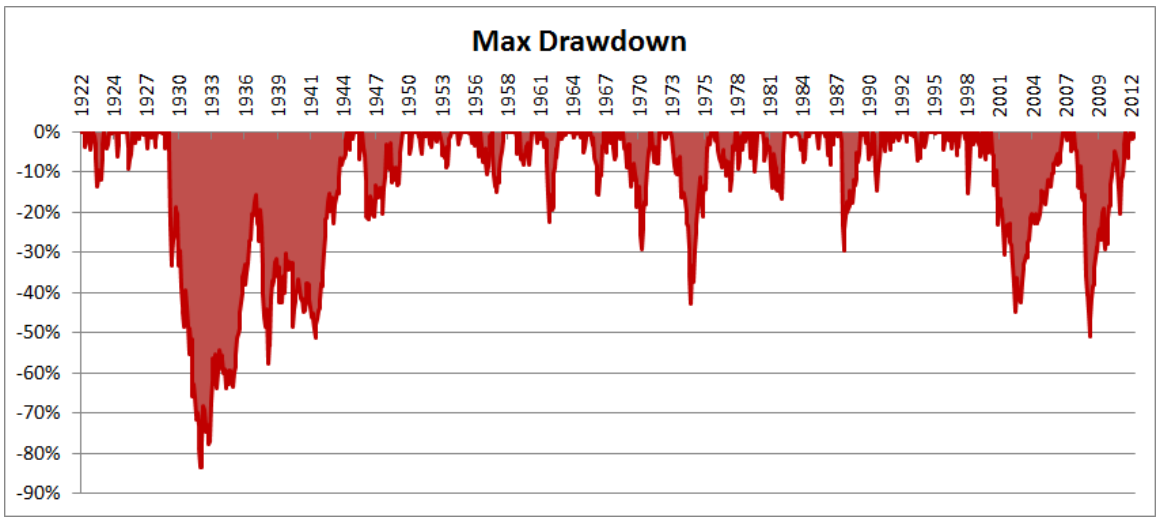
With US assets set to produce uninspiring returns, it makes a lot of sense to look at global assets as well as real assets to protect a portfolio from rising inflation. Figure 4 shows that, while these are some pretty nice returns for these asset classes historically, they are coupled with some large drawdowns. With the exception of U.S. government bonds, which declined less than 20%, the other four asset classes had drawdowns around 50% to 70%. If an investor were to include inflation or take the data back further, those drawdowns only get bigger. Higher resolution daily data and longer look back periods can only increase the drawdown amount. A good rule of thumb is that risky asset classes have Sharpe ratios that cluster around 0.20, while a diversified portfolio is around 0.40.

Figure 4 - Asset Class Maximum Drawdowns 1973-2012

	T-Bills	S&P 500	MSCI EAFE	US 10 YR	GSCI	NAREIT
Return	5.41%	9.70%	9.17%	8.18%	8.32%	9.65%
Volatility	0.95%	15.69%	17.61%	8.44%	20.55%	18.13%
Sharpe (5.41%)	0.00	0.27	0.21	0.33	0.14	0.23
MaxDD	0.00%	-50.95%	-56.40%	-15.79%	-67.65%	-67.88%
Inflation CAGR	4.30%	4.30%	4.30%	4.30%	4.30%	4.30%

To give the reader a visual perspective of drawdowns, Figure 5 shows the drawdowns for stocks for the past 108 years. Drawdowns of 10%-20% are fairly frequent, with 30%-40% drawdowns less so. The large 1920s bear market dominates the figure with a drawdown over 80%.

Figure 5 – S&P 500 Drawdowns, 1900-2012



The former manager of the Harvard endowment, Mohamed El-Erian stated in Kiplinger's in 2009, "Diversification alone is no longer sufficient to temper risk. In the past year, we

saw virtually every asset class hammered. You need something more to manage risk well."

This paper examines a very simple quantitative market-timing model that manages risk. This trend-following model is examined on the U.S. stock market since 1900 before testing across four other markets. The attempt is not to build an optimization model, but rather to build a simple trading model that works in the vast majority of markets. The results suggest that a market timing solution is a risk-reduction technique that signals when an investor should exit a risky asset class in favor of risk-free investments. Instead of offering a lengthy review of the momentum and trendfollowing literature here, the material is included in the Appendix.

The approach is then examined in an allocation framework since 1973 where the empirical results are equity-like returns with bond-like volatility and drawdown. Later in this update we also examine other extensions including alternate allocations, cash management strategies, and more asset classes.

STEP 2 – MANAGE YOUR RISK

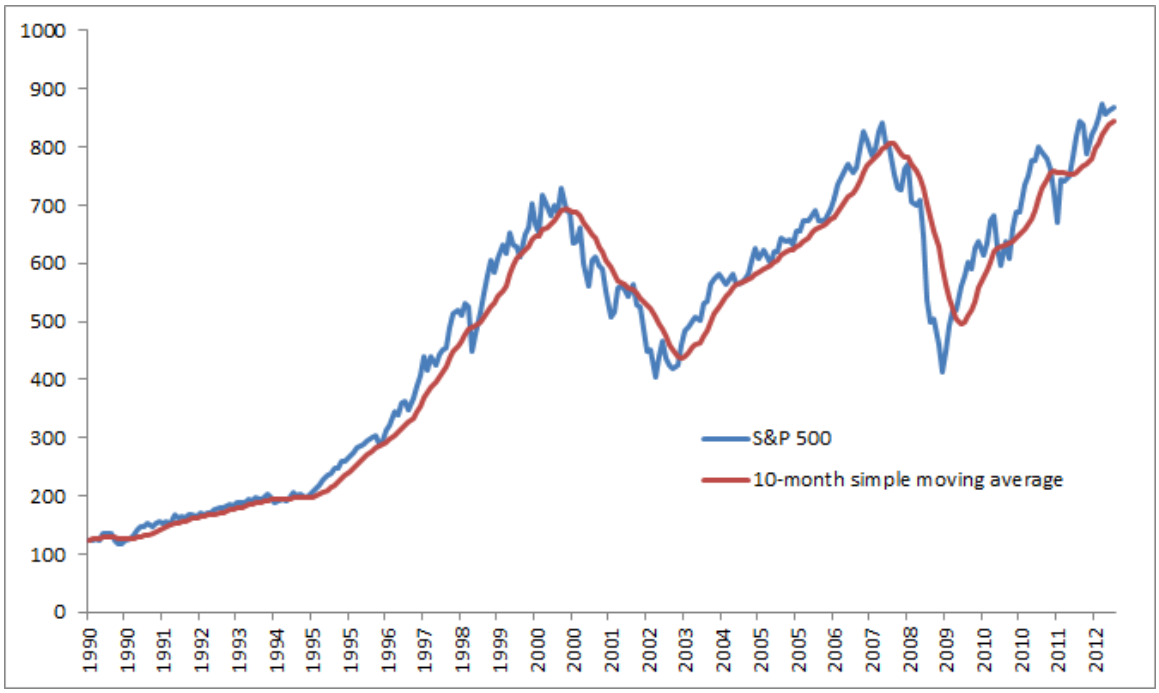
There are a few criteria that are necessary for a model to be simple enough for investors to follow, and mechanical enough to remove emotion and subjective decision-making.

They are:

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

Moving-average-based trading systems are the simplest and most popular trend-following systems (see for example Taylor and Allen (1992) or Lui and Mole (1998)). For those unfamiliar with moving averages, they are a way to reduce noise. The example below shows the S&P 500 with a 10-month simple moving average (SMA).

Figure 6 – S&P 500 vs. 10-Month Simple Moving Average, 1990-2012



The most often cited long-term measure of trend in the technical analysis community is the 200-day simple moving average. In his 2008 book *Stocks for the Long Run 5/E: The Definitive Guide to Financial Market Returns & Long-Term Investment Strategies,* Jeremy Siegel investigates the use of the 200-day SMA in timing the Dow Jones Industrial Average (DJIA) from 1886 to 2006. His test bought the DJIA when it closed at least 1 percent above the 200-day moving average, and sold the DJIA and invested in Treasury bills when it closed at least 1 percent below the 200-day moving average.

He concludes that market timing improves the absolute and risk-adjusted returns over buying and holding the DJIA. Likewise, when all transaction costs are included (taxes,

bid-ask spreads, commissions), the risk-adjusted returns are still higher when employing market timing, though timing falls short on an absolute return measure.

When applied to the NASDAQ Composite Index since 1972, the market timing system thoroughly outperforms buy-and hold, both on an absolute and risk-adjusted basis. Siegel finds that the timing model outperforms buy and hold by over 4% per year from 1972-2006 even when accounting for all costs, and with 25% less volatility. Unfortunately, Siegel does not report drawdown figures, which would have further demonstrated the superiority of the timing model. (Note: Siegel's system is twice as active as the system presented in this paper, thus increasing the transaction costs). Sigel is updating the book with a 2013 edition, and we look forward to see the results including the 2006-2012 period.

It is possible that Siegel already optimized the moving average by looking back over the period in which it is then tested. To alleviate fears of data mining, the approach will be examined across various parameters and other markets to test for validity.
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. The model is only updated once a month on the last day of the month. Price fluctuations during the rest of the month are ignored.
2. All data series are total return series including dividends, updated monthly.
3. Cash returns are estimated with 90-day Treasury bills, 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 the Practical Considerations section later in the paper).

S&P 500 FROM 1901 – 2012

To demonstrate the logic and characteristics of the timing system, we test the S&P 500 back to 1901. Total return series is provided by Global Financial Data and results pre-1971 are constructed by GFD. Data from 1901-1971 uses the Standard and Poor's Composite Price Index and dividend yields supplied by the Cowles Commission and from S&P.

Figure 7 presents the annualized 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 compounded returns while reducing risk, all while being invested in the market

approximately 70% of the time and making less than one round-trip trade per year. (Volatility is measured as the annualized standard deviation of monthly returns.)

Figure 7: S&P 500 Total Returns vs. Timing Total Returns (1901-2012)

	S&P 500	TIMING
Returns	9.32%	10.18%
Volatility	17.87%	11.97%
Sharpe	0.32	0.55
MaxDD	-83.46%	-50.29%
% Positive Months	61.58%	75.80%
$100 becomes	$2,163,361	$5,205,587
Inflation CAGR	3.11%	3.11%

The timing system achieves these superior results while underperforming the index in roughly half of all years since 1901. One of the reasons for the overall outperformance is the lower volatility of the timing system. It is an established fact that high volatility diminishes compound returns. This principle 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 1901 was 11.26%, while timing the S&P 500 returned 11.22%. However, the compounded returns for the two are 9.32% and 10.18%, respectively. Notice that the buy and hold crowd takes a hit of nearly 200 basis points from the effects of volatility, while timing suffers a smaller decline of around 100 basis points. Ed Easterling has a good discussion of these "volatility gremlins" in John Mauldin's 2006 book, *Just One Thing: Twelve of the World's Best Investors Reveal the One Strategy You Can't Overlook.*

Figure 8 shows the superiority of the timing model over the past century, largely avoiding the significant bear markets of the 1930s and 2000s. Figure 8b shows that 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 a more manageable 42.24%.

Figure 8: S&P 500 Total Returns vs. Timing Total Returns (1901-2012)

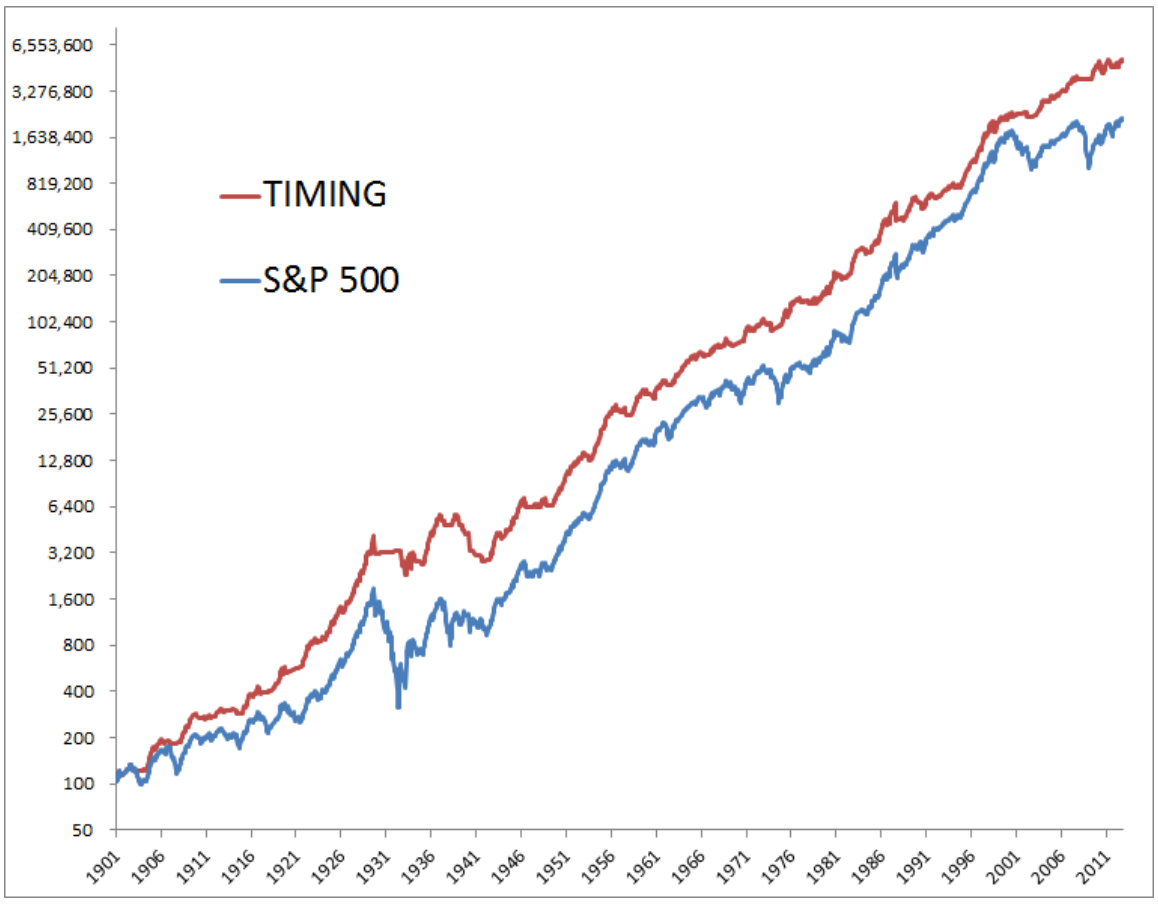


Figure 8b: S&P 500 Drawdowns vs. Timing Drawdowns (1901-2012)

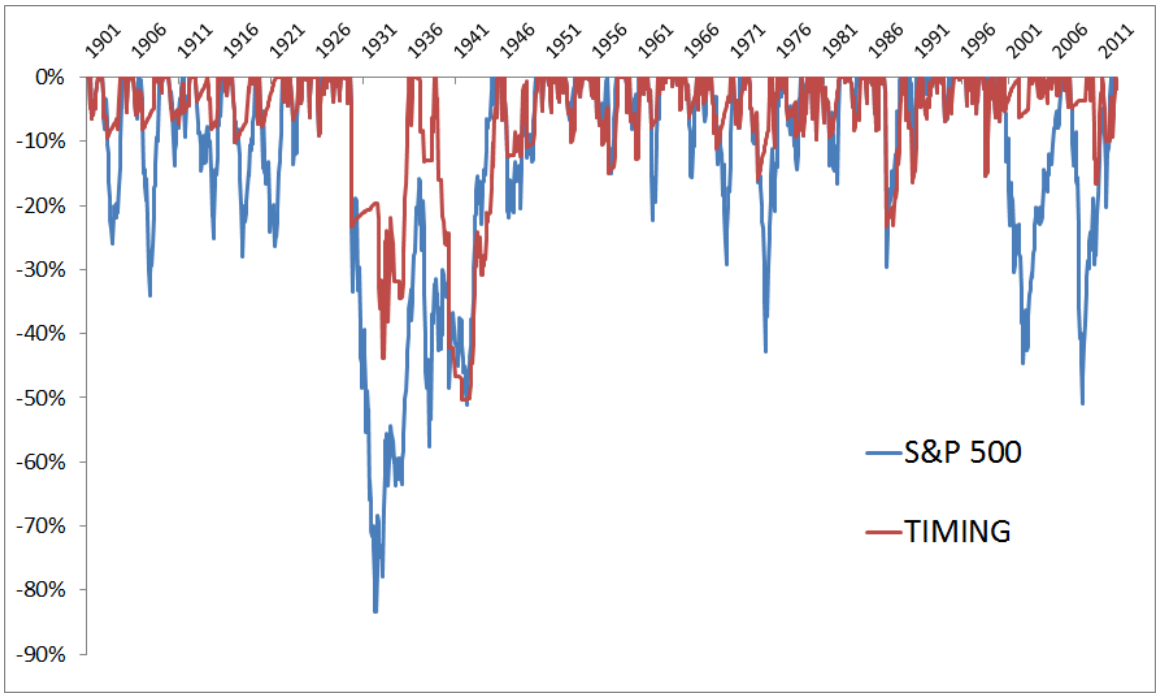
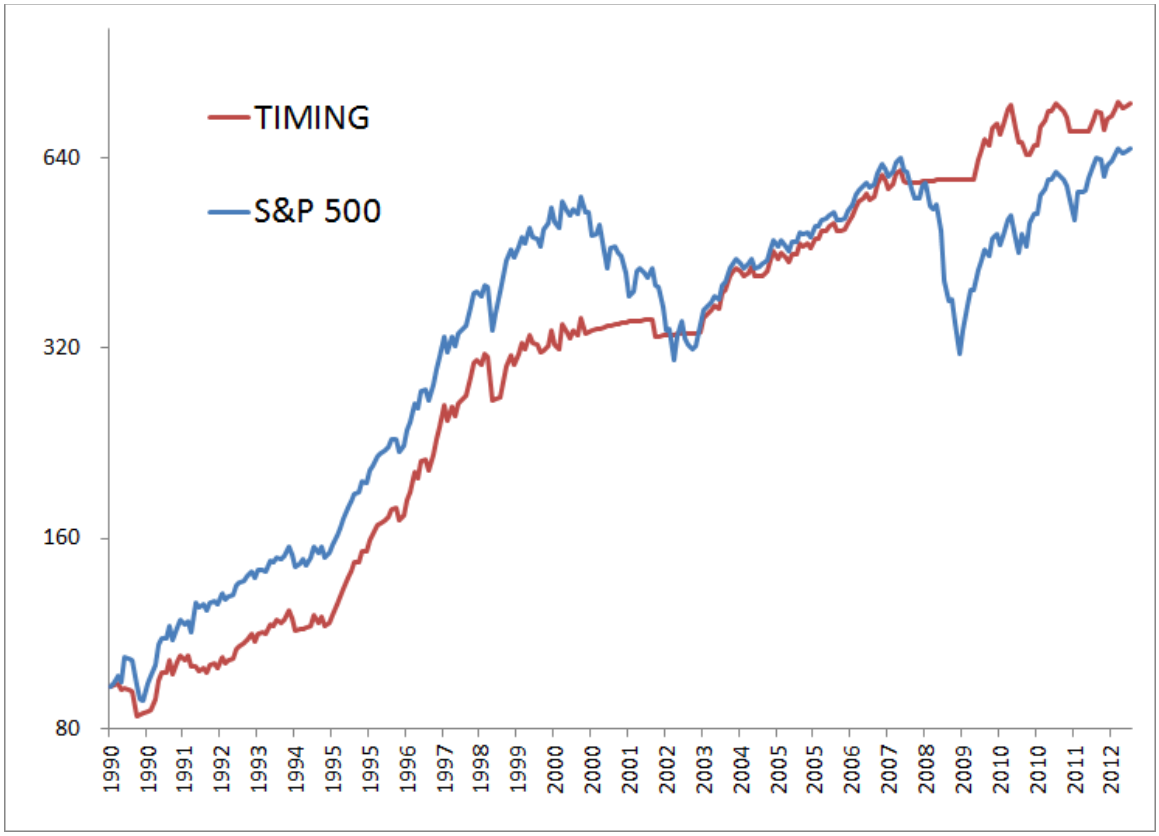


Figure 9 is charted on a non-log scale to detail the differences in the two equity curves. Examining the most recent 22 years, a few features of the timing model stand out**.** First, a trend-following model can underperform buy and hold during a roaring bull market similar to the U.S. equity markets in the 1990s. On the flip side, the timing model can avoid lengthy and protracted bear markets. Consequently, the value added by timing is evident only over the course of entire business cycles.

For example, the timing model exits a long position in October of 2000, thus avoiding two of the three consecutive years of losses, and its 16.52% drawdown is much shallower than the 44.73% setback suffered by buy-and-hold investors. The timing model again

exited the S&P 500 on December 31, 2007 and avoided the entire bear market of 2008-2009 and the 50.95% drawdown.

Figure 9: S&P 500 Total Returns vs. Timing Total Returns (1990-2012)



A glance at Figure 10 presents the 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 for the S&P 500 and the timing model is approximately -0.38, while the correlation for positive years

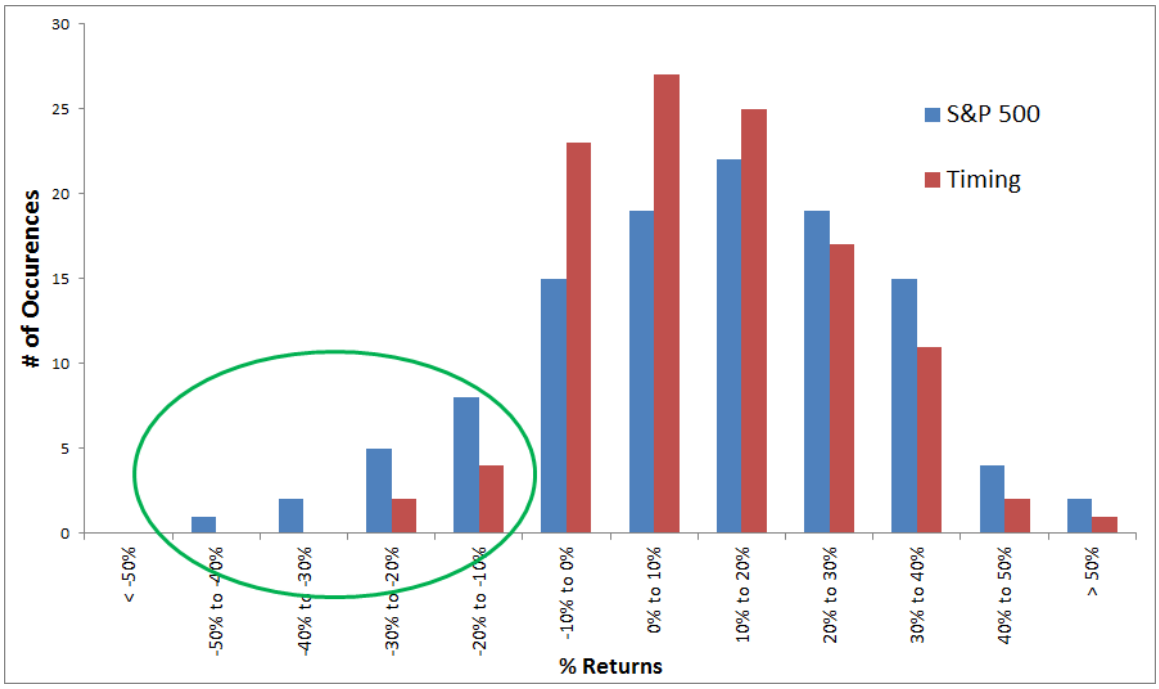
is approximately 0.83. This reflects the ability of the timing model to stay long in up markets while exiting the long position during down markets.

Figure 10: S&P 500 Ten Worst Years vs. Timing, 1900-2012

	S&P 500	TIMING
1931	(43.86%)	1.41%
2008	(36.77%)	1.33%
1937	(35.26%)	(7.65%)
1907	(29.61%)	(0.09%)
1974	(26.47%)	8.16%
1917	(25.26%)	(3.02%)
1930	(25.26%)	2.51%
2002	(22.10%)	(4.62%)
1920	(19.69%)	(4.80%)
1973	(14.69%)	(15.36%)

Figure 11 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 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 (T-bills) that drops the overall risk and drawdown of the portfolio. Most importantly, it avoids the far left tail of big negative losses.

Figure 11: Yearly Return Distribution, S&P 500 and Timing 1900-2012



Appendix B breaks down the returns down by decade for the S&P 500 and the timing model. While the timing model outperforms in about half of all decades on an absolute basis, it improves risk-adjusted returns in about two-thirds of all decades and improves drawdown in all but two decades. Another interesting observation is the wide variance in Sharpe ratios per decade for buy and hold, ranging from -0.23 to 1.44. The past decade has seen compound returns of -0.94% per year for buy and hold while the 1950s saw returns of 19% per year.

STEP 3 - GLOBAL TACTICAL ASSET ALLOCATION

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. Here we introduce a version of the timing model we refer to as "Global Tactical Asset Allocation" or "GTAA". GTAA consists of five global asset classes: US stocks, foreign stocks, bonds, real estate and commodities. The returns for a buy and hold allocation are referenced as "Buy & Hold" or "B&H" and are equally weighted across the five asset classes. The timing model also uses equal weightings and treats each asset class independently – it is either long the asset class or in cash with its 20% allocation of the funds. Figure 12 illustrates the percentage of months in which various numbers of asset classes were held. It is evident that the system keeps the investor 60%-100% invested the vast majority of the time (approximately ~80% of the time the portfolio is at least 60% invested). On average, the investor is 70% invested.

Figure 12: Percent of the Time Invested, 1973-2012

Number of Positions	% Invested	# of Months	% of Months
0 (all cash)	0%	5	1.04%
1	20%	30	6.24%
2	40%	56	11.64%
3	60%	100	20.79%
4	80%	178	37.01%
5	100%	112	23.28%
TOTAL		**481**	**100.00%**

Figures 13 and 13b below present the results for the buying and holding of the five asset classes equal-weighted versus the timing portfolio. The buy and hold returns are quite respectable on a stand-alone basis and present evidence of the benefits of diversification.

Figure 13: Buy & Hold vs. Timing Model, 1973-2012, log scale

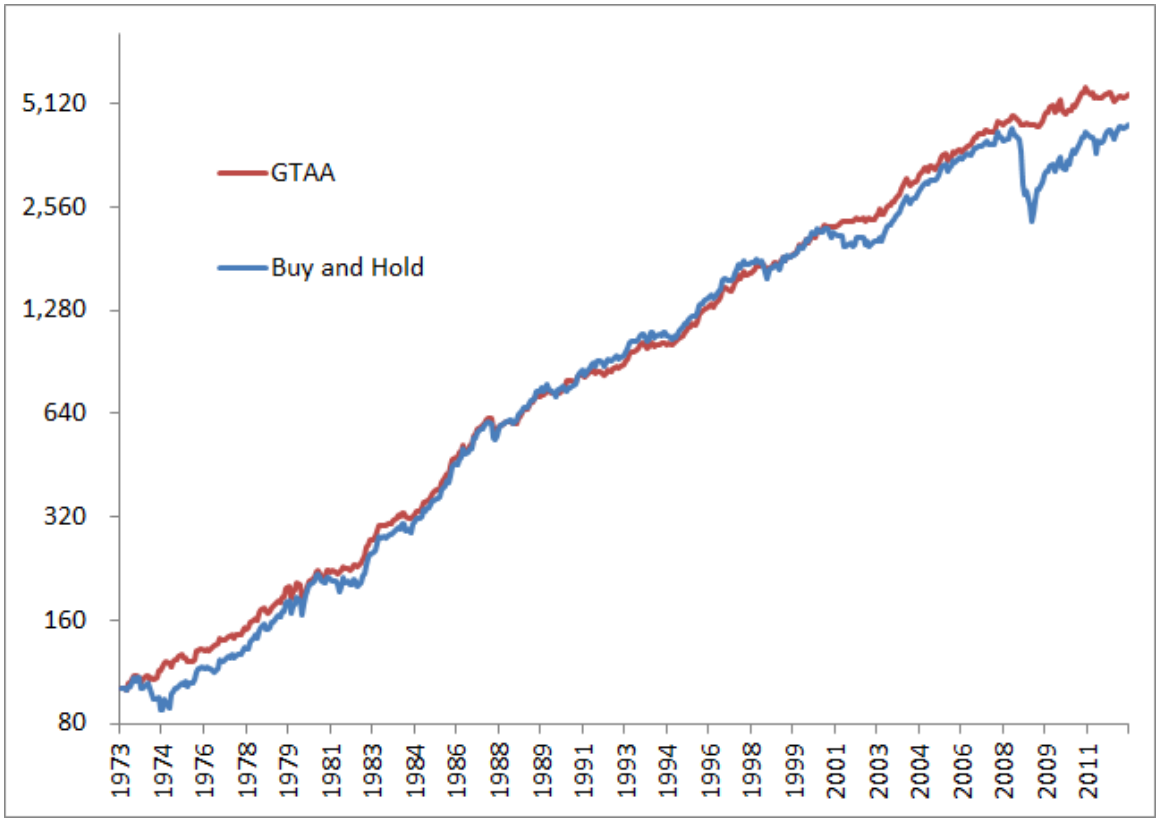
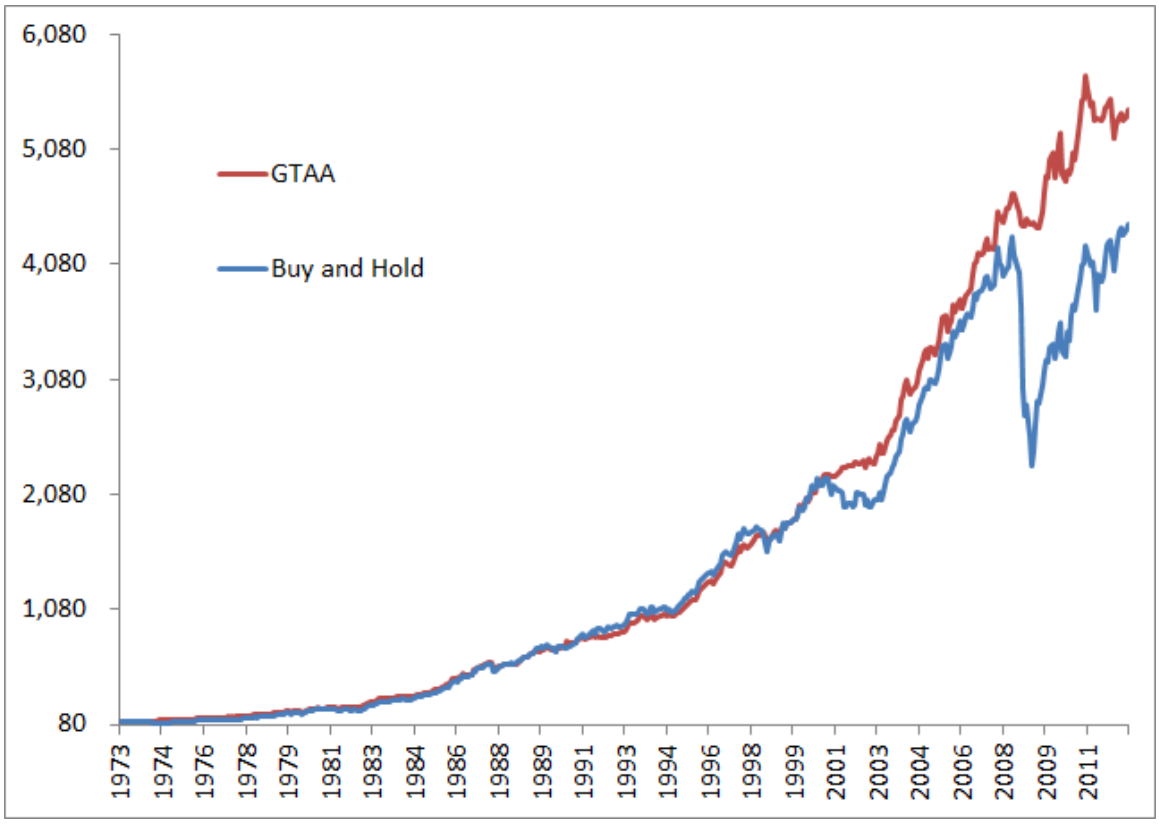


Figure 13b: Buy & Hold vs. Timing Model, 1973-2012, non-log scale



However, the additional advantages conferred by timing are striking. Timing results in a reduction of volatility to single-digit levels, as well as a single-digit maximum drawdown. Drawdown is reduced from 46% to less than 10%, and the investor would have only experienced one down year of less than -1% since inception in 1973. Figure 19 details the yearly returns, and post-2005 is highlighted as the out-of-sample period.

Figure 14: Yearly Returns for Buy & Hold vs. Timing Model, 1973-2012

	B&H	GTAA
1973	1.01%	7.34%
1974	-11.80%	11.92%
1975	20.18%	1.46%
1976	14.93%	15.88%
1977	8.25%	7.32%
1978	13.74%	11.98%
1979	17.99%	14.79%
1980	19.18%	11.91%
1981	-3.12%	3.52%
1982	20.46%	21.03%
1983	18.24%	16.33%
1984	9.32%	6.52%
1985	26.03%	25.65%
1986	25.25%	21.28%
1987	8.68%	11.65%
1988	18.49%	11.76%
1989	19.10%	17.96%
1990	-1.08%	4.92%
1991	18.07%	6.20%
1992	3.90%	4.74%
1993	11.89%	12.79%
1994	1.76%	2.45%
1995	22.75%	21.74%
1996	19.31%	19.25%
1997	9.96%	9.94%
1998	-0.49%	7.34%
1999	14.16%	13.06%
2000	12.73%	13.82%
2001	-9.73%	3.15%
2002	1.99%	3.28%
2003	25.88%	20.45%
2004	17.45%	15.06%
2005	11.73%	7.63%
2006	12.04%	14.21%
2007	7.96%	9.80%
2008	-30.01%	-0.59%
2009	18.74%	12.77%
2010	14.04%	3.65%
2011	2.81%	2.49%
2012	11.57%	1.26%
	B&H	GTAA
Return	9.92%	10.48%
Volatility	10.28%	6.99%
Sharpe (5.41%)	0.44	0.73
MaxDD	-46.00%	-9.54%
Inflation CAGR	4.30%	4.30%

It is possible that Siegel (or others) have optimized the moving average by looking back over the period tested. As a check against optimization, and to show that using the 10-month SMA is not a unique solution, Figure 15 presents the stability of using various moving averages lengths ranging from 3 to 12 months. 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.

Figure 15: Parameter Stability of Various Moving Average Lengths, Timing Model 1973-2012

	BUY & HOLD	3 Month SMA	6 Month SMA	9 Month SMA	12 Month SMA
Return	9.92%	9.54%	10.30%	10.73%	10.59%
Volatility	10.28%	6.92%	6.83%	6.89%	7.09%
Sharpe (5.41%)	0.44	0.60	0.72	0.77	0.73
MaxDD	-46.00%	-17.42%	-9.76%	-10.31%	-14.09%
Inflation CAGR	4.30%	4.30%	4.30%	4.30%	4.30%

While it is instructive to examine the model in various asset classes, the true test of a model is how it performs out of sample in real time. Since the paper was originally published in 2006 with results up to 2005, returns after 2005 should be seen as out of sample. Figure 16 illustrates the returns for B&H and timing portfolios.

Figure 16: Summary Annualized Returns for B&H vs. Timing Model, 2006-2012

	BUY & HOLD	GTAA
Return	3.94%	6.01%
Volatility	14.96%	7.27%
Sharpe (5.41%)	0.16	0.61
MaxDD	-46.00%	-9.42%
Inflation CAGR	2.20%	2.20%

The model performed exactly as one would expect it to from historical data. Namely, even though it only outperformed in three out of seven years, it beat buy and hold by over two percentage points per year, with much less volatility and most importantly to many investors, lower drawdowns.

PRACTICAL CONSIDERATIONS AND TAXES

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 both the buy and hold and timing models, and will vary depending on the instrument used for investing. 0.10% to 0.70% is a fair estimate range for these fees using ETFs and no-load mutual funds (obviously the lower the better). Many all-ETF portfolios can be formed for approximately 0.1% to 0.3%.

Commissions should be a minimal factor due to the low turnover of the models. On average, the investor would be making three to four round-trip trades per year for the portfolio and less than one round-trip trade per asset class per year. Likewise, slippage should be nearly negligible, as there are numerous mutual funds (end-of-day pricing means zero slippage) as well as liquid ETFs an investor can choose from.

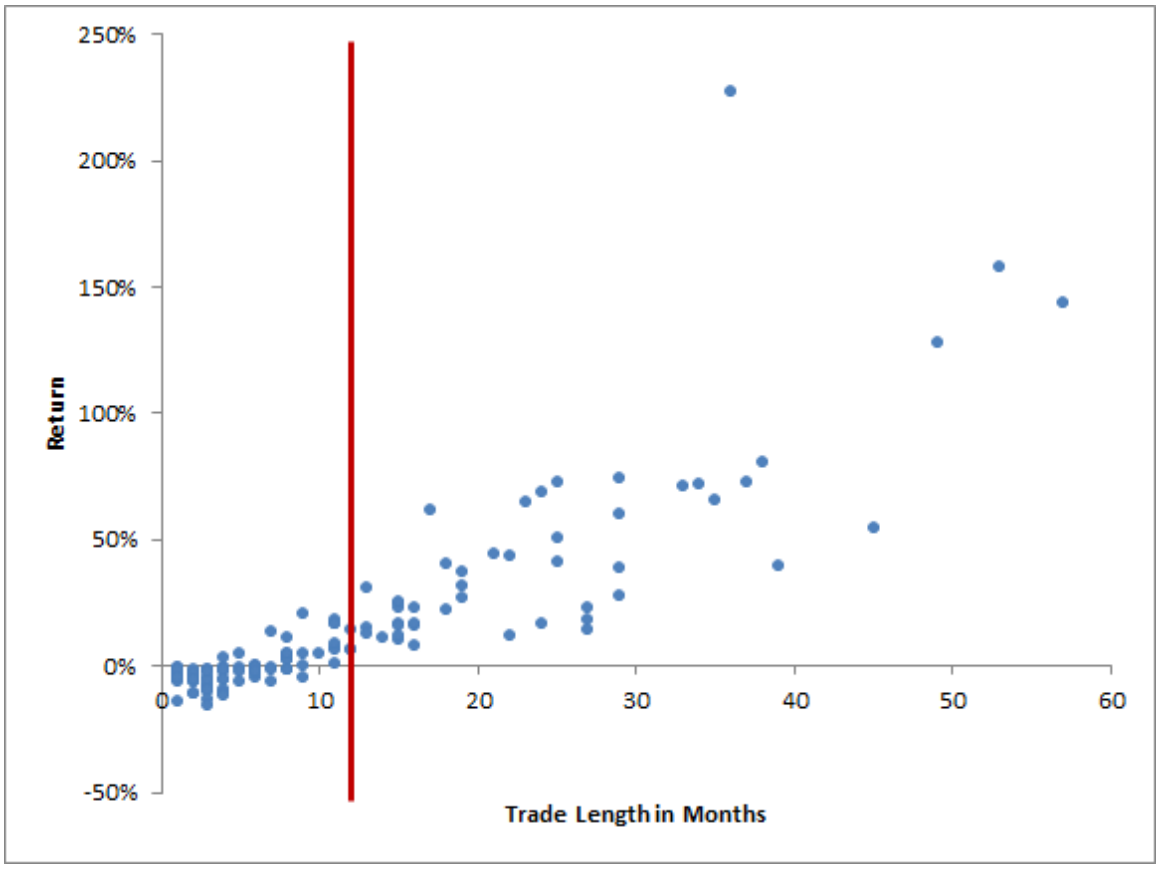
Taxes, on the other hand, are a very real consideration. Many institutional investors such as endowments and pension funds enjoy tax-exempt status. The obvious solution for individuals is to trade the system in a tax-deferred account such as an IRA or 401(k). Due to the various capital gains rates for different investors (as well as varying tax rates across time, as well as the impact of dividends) it is difficult to estimate the hit an investor would suffer from trading this system in a taxable account. Most investors rebalance their holdings periodically and introduce some turnover into the portfolio even

for a buy and hold allocation – and it is reasonable to assume a normal turnover of approximately 20%. The system has a turnover of almost 70%.

Gannon and Blum (2006) presented after-tax returns for individuals invested in the S&P 500 since 1961 in the highest tax bracket. After-tax returns to investors with 20% turnover would have fallen to 6.72% from a pre-tax return of 10.62%. They estimate that an increase in turnover from 20%-70% would have resulted in an additional haircut of less than 50 basis points to 6.27%.

There is some good news for those who have to trade this model in a taxable account. The system results in a high number of short-term capital losses, and a large percentage of long-term capital gains. Figure 17 depicts the distribution for all the trades for the five asset classes since 1973. This should help reduce an investor's tax burden.

Figure 17: Length of Trades for Timing Model, 1973-2012



WHY IT WORKS - VOLATILITY CLUSTERING

One of the benefits of a quantitative system is that it protects the investor from innate behavioral biases. A discussion of some of the more insidious biases can be found in the Appendix. Of course, this information is not only valuable for figuring out our own biases - other people's mistakes leave the door open for us to soak up some of that elusive alpha. As far as excess returns are concerned, for someone to gain, someone else has to lose. People consistently make the same mistakes that are hard-wired into their brains, and they do so over and over again.

Humans use a different part of their brain when they are losing money than when they are making money. We put together a 17-page white paper to address the topic called "Where the Black Swans Hide and the Ten Best Days Myth".

Figure 18 shows the annualized returns and volatility for the five markets we studied in this paper. On average, the returns are 60% lower and the volatility 30% higher when the market is below its 10-month simple moving average. Commodities are the one exception where volatility is not higher when below the moving average, which makes intuitive sense. Commodities are often driven by supply shocks that can result in price spikes.

2008 is a prime example with volatility levels in stock markets around the globe exploding to record levels. However, this volatility has occurred *after* the markets already began declining.

Figure 18: Volatility Clustering Across Various Asset Classes

Asset Class 1973-2012	Market > 10 month SMA	Market < 10 month SMA	Difference
US Stocks			
% of time	72.92%	27.08%	
Annualized Return	13.48%	5.49%	-59.27%
Annualized Volatility	13.79%	19.93%	44.48%
Foreign Stocks			
% of time	69.17%	30.83%	
Annualized Return	13.62%	5.28%	-61.20%
Annualized Volatility	15.13%	22.20%	46.66%
Bonds			
% of time	75.83%	24.17%	
Annualized Return	8.38%	9.02%	7.71%
Annualized Volatility	8.24%	9.10%	10.32%
Commodities			
% of time	65.21%	34.79%	
Annualized Return	14.10%	4.44%	-68.47%
Annualized Volatility	20.72%	20.20%	-2.51%
Real Estate			
% of time	72.92%	27.08%	
Annualized Return	16.39%	-0.39%	-102.37%
Annualized Volatility	13.79%	26.32%	90.87%
AVERAGE			
% of time	71.21%	28.79%	
Annualized Return	13.19%	4.77%	-63.84%
Annualized Volatility	14.34%	19.55%	36.35%
AVERAGE (w/o Commodities)			
% of time	72.71%	27.29%	
Annualized Return	12.97%	4.85%	-62.58%
Annualized Volatility	12.74%	19.38%	52.15%
US Stocks 1901-2008			
% of time	69.91%	30.09%	
Annualized Return	14.54%	3.67%	-74.75%
Annualized Volatility	14.27%	24.20%	69.61%

EXTENSIONS

Since the publication of the original white paper we have written two books, over ten white papers, and over one thousand articles on the blog Mebane Faber Research. While the intent of this paper was to demonstrate a simple tactical system, there are significant departures an investor can take to tailor the portfolio to their particular situation. We will examine these below:

1. Adding more asset classes
2. Alternative cash management strategies.
3. Alternate weighting strategies.

EXTENSION 1 – MORE ASSET CLASSES

Other than simplicity, there is no reason to only focus on five asset classes. (Technically, we believe there are only four real asset classes: stocks, bonds, commodities, and currencies. Everything else (like REITs) is a combination of the prior four.)

At the same time, expanding a portfolio with allocations less than 5% of the total does not do enough to move the needle on the entire portfolio's risk and reward characteristics. (This ignores derivatives and holdings with highly asymmetric payoffs).

We also have the challenge that many asset classes and indexes simply have not existed for a very long time. For example, we do not include TIPs, junk or high yield bonds, emerging bonds, foreign REITs, fundamental indexes, managed futures, currencies, or other asset classes we might otherwise consider. However, thirteen asset class subgroups will likely cover the majority of the world that we would like to allocate to.

Below we expand the original portfolio from:

Allocaiton	Asset Class (Subgroup)	Index
20%	US Large Cap	S&P 500
20%	Foreign Developed	MSCI EAFE
20%	US 10 Year Government Bonds	GFD
20%	Commodities	Goldman Sachs Commodity Index
20%	Real Estate Investment Trusts	NAREIT Index

…to include the following:

Allocaiton	Asset Class (Subgroup)	Index
5%	US Large Cap Value	French Fama
5%	US Large Cap Momentum	French Fama
5%	US Small Cap Value	French Fama
5%	US Small Cap Momentum	French Fama
10%	Foreign Developed	MSCI EAFE
10%	Foreign Emerging	MSCI EEM
5%	US 10 Year Government Bonds	GFD
5%	Foreign 10 Year Government Bonds	GFD
5%	US Corporate Bonds	GFD
5%	US 30 Year Government Bonds	GFD
10%	Commodities	Goldman Sachs Commodity Index
10%	Commodities	Gold
20%	Real Estate Investment Trusts	NAREIT Index

We then take a look at the historical returns compared to the simple strategy of five asset classes. As you can see, it improves returns about 150 basis points, likely enough to warrant increasing the assets in the portfolio.

Figure 18: Buy and Hold and GTAA Portfolios, 1973-2012

	B & H 5	GTAA 5	B & H 13	GTAA 13
1973	1.01%	7.34%	3.42%	8.65%
1974	-11.80%	11.92%	-8.95%	12.83%
1975	20.18%	1.46%	18.86%	4.44%
1976	14.93%	15.88%	21.56%	19.88%
1977	8.25%	7.32%	15.95%	14.74%
1978	13.74%	11.98%	16.56%	13.62%
1979	17.99%	14.79%	32.66%	26.76%
1980	19.18%	11.91%	21.80%	15.73%
1981	-3.12%	3.52%	-3.70%	5.97%
1982	20.46%	21.03%	19.52%	23.56%
1983	18.24%	16.33%	16.84%	15.85%
1984	9.32%	6.52%	7.45%	9.94%
1985	26.03%	25.65%	23.77%	23.30%
1986	25.25%	21.28%	22.68%	19.93%
1987	8.68%	11.65%	8.30%	8.35%
1988	18.49%	11.76%	16.66%	11.02%
1989	19.10%	17.96%	18.83%	20.35%
1990	-1.08%	4.92%	-4.55%	2.86%
1991	18.07%	6.20%	24.06%	13.30%
1992	3.90%	4.74%	8.33%	7.42%
1993	11.89%	12.79%	22.40%	21.67%
1994	1.76%	2.45%	-0.60%	-0.50%
1995	22.75%	21.74%	17.88%	17.66%
1996	19.31%	19.25%	15.52%	15.09%
1997	9.96%	9.94%	7.41%	11.05%
1998	-0.49%	7.34%	-3.10%	6.32%
1999	14.16%	13.06%	13.86%	13.21%
2000	12.73%	13.82%	6.94%	8.90%
2001	-9.73%	3.15%	1.11%	4.39%
2002	1.99%	3.28%	3.65%	3.03%
2003	25.88%	20.45%	32.24%	28.09%
2004	17.45%	15.06%	18.94%	15.14%
2005	11.73%	7.63%	13.75%	10.78%
2006	12.04%	14.21%	17.25%	16.45%
2007	7.96%	9.80%	8.94%	12.33%
2008	-30.01%	-0.59%	-28.26%	-3.25%
2009	18.74%	12.77%	26.97%	18.39%
2010	14.04%	3.65%	19.29%	10.22%
2011	2.81%	2.49%	1.97%	2.65%
2012	11.57%	1.26%	13.93%	2.35%
	B & H 5	GTAA 5	B & H 13	GTAA 13
Return	9.92%	10.48%	11.54%	12.04%
Volatility	10.28%	6.99%	10.70%	7.09%
Sharpe (5.41%)	0.44	0.73	0.57	0.94
MaxDD	-46.00%	-9.54%	-42.66%	-10.74%
Inflation CAGR	4.30%	4.30%	4.30%	4.30%

EXTENSION 2 – ALTERNATIVE CASH MANAGEMENT STRATEGIES

On average the tactical portfolio is invested in 30% cash. This is a drag on the portfolio, and many investors employ other means to increase the yield on the cash portion of the portfolio using any number of funds or concepts. Below we look at a simple method of taking on more duration risk by investing the portfolio in 10-year government bonds instead of Treasury Bills.

Figure 19: Buy and Hold and GTAA Portfolios, 1973-2012

1973-2012	GTAA 13 Tbills	GTAA 13 10 Year
Return	12.04%	13.41%
Volatility	7.09%	8.14%
Sharpe (5.41%)	0.94	0.98
MaxDD	-10.74%	-11.90%
Inflation CAGR	4.30%	4.30%

An investor would have realized an additional 1.37% per annum in returns for marginally more volatility and drawdown – but how much of this is simply due to the major bull market in bonds? We decided to examine a period of sharply rising interest rates from 1973-1981, and found that the benefit of taking on additional duration risk actually helped!

Figure 19: Buy and Hold and GTAA Portfolios, 1973-1981

1973-1982	GTAA 13 Tbills	GTAA 13 10 Year
Return	12.09%	13.69%
Volatility	7.10%	6.79%
Sharpe (5.41%)	0.52	0.78
MaxDD	-10.32%	-11.90%
Inflation CAGR	9.13%	9.13%

EXTENSION 3 – WEIGHTING STRATEGIES

No two investors are alike. Some investors value wealth preservation with low volatility above all else, while others can handle a 50% loss in an attempt at generating higher gains.

Below we look at a few different allocations that we will call GTAA Conservative, Moderate, and Aggressive.

GTAA Conservative

This allocation broadly follows the allocation of GTAA Moderate, but with more in bonds (40% vs. 20%). Cash is invested in 10 Year US Government Bonds.

Allocaiton	Asset Class (Subgroup)	Index
3.75%	US Large Cap Value	French Fama
3.75%	US Large Cap Momentum	French Fama
3.75%	US Small Cap Value	French Fama
3.75%	US Small Cap Momentum	French Fama
7.50%	Foreign Developed	MSCI EAFE
7.50%	Foreign Emerging	MSCI EEM
10.00%	US 10 Year Government Bonds	GFD
10.00%	oreign 10 Year Government Bonc	GFD
10.00%	US Corporate Bonds	GFD
10.00%	US 30 Year Government Bonds	GFD
7.50%	Commodities	Goldman Sachs Commodity Index
7.50%	Commodities	Gold
15.00%	Real Estate Investment Trusts	NAREIT Index

GTAA Moderate

This allocation is the same as mentioned in the prior Extension.

Allocaiton	Asset Class (Subgroup)	Index
5%	US Large Cap Value	French Fama
5%	US Large Cap Momentum	French Fama
5%	US Small Cap Value	French Fama
5%	US Small Cap Momentum	French Fama
10%	Foreign Developed	MSCI EAFE
10%	Foreign Emerging	MSCI EEM
5%	US 10 Year Government Bonds	GFD
5%	Foreign 10 Year Government Bonds	GFD
5%	US Corporate Bonds	GFD
5%	US 30 Year Government Bonds	GFD
10%	Commodities	Goldman Sachs Commodity Index
10%	Commodities	Gold
20%	Real Estate Investment Trusts	NAREIT Index

GTAA Aggressive

This portfolio begins with the asset classes listed in the GTAA Moderate allocation. It then selects the top six out of the thirteen assets as ranked by an average of 1, 3, 6, and 12-month total returns (momentum). This method was detailed in our white paper "Relative Strength Strategies for Investing". The assets are only included if they are above their long-term moving average, otherwise that portion of the portfolio is moved to cash. We also include the effects of only investing in the top three out of thirteen assets.

Another extension we covered is to apply leverage to generate excess returns. An investor would simply invest twice as much in each asset class, and the maximum portfolio exposure would be 200% if all of the asset classes were on buy signals simultaneously.

Note: Implementing the leveraged model at many retail brokerages is not ideal due to prohibitive borrowing costs. Leveraged ETFs likewise are not ideal due to large tracking error relative to the benchmark index. An investor must be careful when pursuing leveraged returns.

Figure 20: Buy & Hold vs. Various GTAA Allocations, 1973-2012

	B & H 13	GTAA 13 CON	GTAA 13 MOD	GTAA 13 AGG Top 6	GTAA 13 AGG Top 3	GTAA 13 2X Leverage
1973	3.42%	5.87%	8.65%	18.42%	33.89%	9.19%
1974	-8.95%	9.01%	12.83%	16.04%	27.19%	17.54%
1975	18.86%	7.40%	4.44%	9.81%	3.26%	2.74%
1976	21.56%	22.07%	19.88%	35.26%	35.47%	35.57%
1977	15.95%	12.38%	14.74%	15.47%	18.46%	24.39%
1978	16.56%	9.90%	13.62%	17.70%	7.58%	18.55%
1979	32.66%	22.01%	26.76%	45.71%	56.36%	42.82%
1980	21.80%	18.42%	15.73%	34.09%	35.18%	22.48%
1981	-3.70%	7.61%	5.97%	9.69%	9.25%	6.44%
1982	19.52%	34.25%	23.56%	35.25%	42.85%	36.38%
1983	16.84%	12.91%	15.85%	20.63%	20.76%	22.30%
1984	7.45%	15.78%	9.94%	16.53%	14.20%	14.48%
1985	23.77%	28.18%	23.30%	32.40%	34.17%	39.88%
1986	22.68%	22.08%	19.93%	25.59%	27.51%	33.81%
1987	8.30%	8.18%	8.35%	-0.07%	6.76%	9.72%
1988	16.66%	12.46%	11.02%	14.62%	12.39%	15.60%
1989	18.83%	21.02%	20.35%	31.08%	32.81%	32.38%
1990	-4.55%	6.07%	2.86%	-1.19%	-0.86%	0.75%
1991	24.06%	16.49%	13.30%	19.00%	26.21%	20.27%
1992	8.33%	8.75%	7.42%	16.14%	15.19%	10.52%
1993	22.40%	22.01%	21.67%	27.43%	30.60%	41.34%
1994	-0.60%	-4.49%	-0.50%	-5.76%	-4.17%	-5.44%
1995	17.88%	24.32%	17.66%	32.16%	33.39%	31.75%
1996	15.52%	11.50%	15.09%	20.01%	26.51%	24.17%
1997	7.41%	12.11%	11.05%	23.48%	26.86%	15.37%
1998	-3.10%	13.36%	6.32%	13.80%	10.32%	10.41%
1999	13.86%	3.84%	13.21%	26.51%	38.69%	20.99%
2000	6.94%	13.67%	8.90%	10.36%	10.20%	10.88%
2001	1.11%	5.08%	4.39%	-2.20%	-2.20%	5.07%
2002	3.65%	8.10%	3.03%	13.64%	6.59%	2.91%
2003	32.24%	23.65%	28.09%	36.95%	46.69%	59.59%
2004	18.94%	14.63%	15.14%	17.36%	13.76%	27.81%
2005	13.75%	9.36%	10.78%	11.10%	11.02%	16.62%
2006	17.25%	12.13%	16.45%	21.47%	28.59%	27.04%
2007	8.94%	13.51%	12.33%	14.42%	27.57%	18.88%
2008	-28.26%	14.74%	-3.25%	12.11%	12.25%	4.13%
2009	26.97%	7.15%	18.39%	17.96%	14.24%	32.42%
2010	19.29%	11.58%	10.22%	12.37%	6.58%	18.42%
2011	1.97%	7.99%	2.65%	6.76%	1.19%	5.24%
2012	13.93%	3.25%	2.35%	11.24%	2.73%	3.44%
	B & H 13	GTAA 13 CON	GTAA 13 MOD	GTAA 13 AGG Top 6	GTAA 13 AGG Top 3	GTAA 13 2X Leverage
Return	11.54%	12.94%	12.04%	17.76%	19.10%	18.86%
Volatility	10.70%	7.42%	7.09%	11.61%	14.82%	14.45%
Sharpe (5.41%)	0.57	1.01	0.94	1.06	0.92	0.93
MaxDD	-42.66%	-10.72%	-10.74%	-23.43%	-20.29%	-23.67%
Inflation CAGR	4.30%	4.30%	4.30%	4.30%	4.30%	4.30%

CONCLUSIONS

The purpose in this paper was to create a simple-to-follow method for managing risk in a single asset class and, by extension, a portfolio of assets. A non-discretionary, trend-following model acts as a risk-reduction technique with no adverse impact on return. Utilizing a monthly system since 1973, an investor would have been able to increase risk-adjusted returns by diversifying portfolio assets and employing a market-timing solution. In addition, the investor would have also been able to sidestep 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. Investors looking to tailor their portfolio may consider using alternate cash strategies, more assets in the portfolio, and alternative weighting schemes to find a portfolio that is right for them.

FAQs

Below is a compilation of frequently asked questions we receive on a regular basis about the broad global tactical strategies presented in our book and white papers. While we cannot speak specifically to how we manage money, we can speak broadly to the strategies in this paper.

We try to be as open and honest about the benefits as well as the drawbacks of every strategy and approach we research.

Of utmost importance is finding an asset management program and process that is *right for you*.

Where did you get your historical data? Can you send it to me?

We used Global Financial Data and our agreement does not allow us to share the data. However, there are many free sources of data available including this post we did on a list of free data sources.

How do you update this model? What do you mean by "monthly price"?

The model, as published, is only updated once a month on the last day of the month. Market action in the meantime is ignored. The published model was only meant to be broadly representative of the performance one could expect from such a simple system.

Have you examined an all-in version where you invest 100% of the assets in whatever asset classes are on a buy signal?

Yes, but this eliminates the benefits of diversification and exposes the portfolio to large risks when only a few asset classes are on a buy signal. In addition, it introduces unnecessary transaction costs. Returns are higher but with an unnecessary increase in risk. Investors seeking higher returns can use leverage or employ some of the rotation techniques mentioned in this paper.

Do you rebalance the asset classes monthly?

Yes. Although we show in the book The Ivy Portfolio that it is important to rebalance sometime, the frequency is not that important. For buy and hold allocations we recommend a yearly rebalance in tax-exempt accounts, and rebalancing based on cash flows in taxable accounts. Percentage tolerance bands are another option for rebalancing decisions.

Have you tried various moving averages?

Yes. There is broad parameter stability from 3 months on out to over 12 months.

I like the strategy and want to implement it, should I wait until the next rebalance?

We usually invest immediately at the rebalance point. While this can have a significant effect on short-term results, it should be a wash in the long term. Investors worried about the short term can stagger their purchases over a number of months or quarters.

Where can I track the strategy?

You can track the strategy on a number of websites including StockCharts.com. We also have a tracking feature on the blog.

What about using daily or weekly data? Doesn't only updating monthly expose an investor to dramatic price movements in the interim?

We have seen confirming data for various timeframes, some superior, and some inferior. The question is valid - but also consider the opposite scenario. What happens to a system that updates daily where a market goes down fast, then reverses and goes straight back up? The investor would have been whipsawed and lost capital. We expect the timeframes to have similar performance over the long term.

What is the best way for an individual to implement the leveraged model?

This is tricky. If your broker has reasonable margin rates then leverage is justified. Interactive Brokers is consistently fair here. For investors familiar with the product, futures are a good choice. One can also use an all-in cross-market rotation system detailed in the paper.

Why are you taking credit for using the 200-day moving average model?

We're not, and we are very upfront that trendfollowing models have been around for over 100 years.

For the rotation system you've written about where you purchase the top performer over the past 1, 3, 6, 12 month periods, are you simply using the mean of the 1, 3, 6, 12 month performance to calculate the top performer?

Yes.

Is the 10-month SMA crossover optimized for all (five) asset classes, or is it possible that different timeframes could work better for different asset classes?

Different timeframes will certainly work better (in the past), but what is unknown is the parameter that will work best in the future. However, there is broad parameter stability across many different moving average lengths.

Have you ever tried adding gold to your model (or any other asset class)?

Yes, we use over 50 asset classes at Cambria – the paper is meant to be instructive.

Why did you choose the 10-month SMA?

Just to be representative of the strategy, and it also corresponds closest to the 200 day moving average. We chose monthly since daily data does not go back that far for many of the asset classes.

What software did you use to perform the historical backtests?

Excel.

I am trying to replicate your results with X (Yahoo, Google, etc.) database and my results don't match. What gives?

The indexes disclosed in the paper and book are obtained from Global Financial Data. We cannot fact check all of the data sources to see how they calculate their numbers but make certain that the numbers are total return including dividends and income. For Yahoo Finance one needs to use the adjusted numbers – AND make sure to adjust them every month (or record the new returns for that month), a tedious process.

How is your ETF different then the model you presented in the white paper and book?

We cannot address questions about our funds here. Feel free to email us or visit the fund information page here:

http://advisorshares.com/fund/gtaa

Why the expansion from five to more asset classes? Have you tested this increased granularity?

Yes we have performed extensive research in house that demonstrates that increasing the number of asset classes (and sub asset classes and industries) that are not perfectly correlated improves risk-adjusted performance. You can find a brief post here on our blog.

What is the long term expected volatility and drawdown targets? Is 10% maximum drawdown for the GTAA Moderate strategy reasonable?

While the historical volatility (7%) and maximum drawdown (-10%) are good targets, by definition a portfolios largest drawdown is always in the future. We foresee the possibility of a 20% drawdown as a possible scenario.

How will trend-following asset allocation perform in sideways markets?

In general, a market that oscillates can be a poor market for trendfollowers do to whipsaws. However, one that examines Japan – a market that has had very poor performance for the past 20 years – would find that a trendfollowing approach would have still added significant value.

What do you anticipate the long-term correlation of this strategy to be, with the S&P 500?

This is a difficult question to answer since correlations are inherently unstable. However, since most of the portfolio is in equity-like assets we expect the correlation to be quite positive. Historically the correlation has been around 0.7 with buy and hold and 0.5 with the S&P 500.

In your opinion, is this strategy diversified enough for an investor to have a large % of his assets in it?

The strategy is designed as a core holding and an "all-weather" portfolio designed to perform in any market environment. The fund's underlying holdings represent over 20,000 securities across the globe.

I can see using the strategy as a core holding, however, because it can hypothetically have a significant equity exposure, what is the largest allocation you would give it in a conservative account? 25%?

That depends entirely on the investor and their risk and return objectives. The fund is targeting equity like returns with reduced risk, and depending on the investor that is appropriate for a 0% to 100% allocation.

It doesn't look like it benefits the portfolio much to time the bond portion, thoughts?

Trading lower volatility bonds doesn't have much of a benefit, but timing higher volatility bonds (junk, emerging, corporate) tends to work well.

DATA SOURCES

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 the Cowles Commission and from S&P itself.

MSCI EAFE Index (Europe, Australasia, Far East) – A free float-adjusted market capitalization index that is designed to measure the equity market performance of developed markets, excluding the US & Canada. As of June 2007 the MSCI EAFE Index consisted of the following 21 developed market country indices: Australia, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and the United Kingdom. Total return series is provided by Morgan Stanley.

U.S. 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. 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.

APPENDIX A - LITERATURE REVIEW MOMENTUM & TREND-FOLLOWING

The application of a trend-following methodology to financial markets is not a new endeavor, and an entire book by Michael Covel (2009) has been written on the subject. The rules and criteria of a trend-following strategy are incredibly varied and unique. Although we will touch briefly on some of the academic literature here, a more thorough treatment of the subject is presented by Tezel and McManus (2001), as well as by Carr *Smarter Investing in Any Economy* (2008) and Ostgaard *"*On the Nature and Origins of Trend-Following*"* (2008).

There have been many attempts to describe the success of trend following and momentum trading systems. Kahneman and Tversky (1979) provided a behavioral framework entitled prospect theory that describes how humans have an irrational tendency to be less willing to gamble with profits than with losses. In short, investors tend to sell their winners too early, and hold on to losers too long.

Two of the oldest and most discussed trend-following systems are the Dow Theory, developed by Charles Dow, and the Four Percent Model, developed by Ned Davis. *The Research Driven Investor* by Timothy Hayes (2001) and *Winning on Wall Street* by Martin Zweig (1986) present good reviews of each system, respectively.

Alfred Cowles and Herbert Jones found evidence of momentum as early as the 1930s (1937). H.M. Gartley (1945) mentions methods of relative strength stock selection in his *Financial Analysts Journal* article "Relative Velocity Statistics: Their Application in Portfolio Analysis." Robert Levy (1968) identified his own system in *The Relative Strength Concept of Common Stock Price Forecasting*. Other literature penned by investors who suggest using momentum in stock selection include James O'Shaughnessy's (2011) book, *What Works on Wall Street*, William O'Neil's (1988) *How to Make Money in Stocks*, and Nicolas Darvas's (1960) *How I Made $ 2,000,000 in the Stock Market*.

The group at Merriman Capital Management (MCM) has completed a number of quantitative backtests utilizing market timing on equities, bonds, and gold. The group uses their own strategies to manage client money. Tilley and Merriman (1998-2002) describe the characteristics of a market-timing system, as well as the emotional and behavioral difficulties in following such a system.

Wilcox and Crittenden (2005), in "Does Trend-Following Work on Stocks?", take up that question applied to the domestic equities market and conclude that trend-following can work well on stocks even when adjusting for corporate actions, survivorship bias, liquidity, and transaction costs.

An entirely different product area where trend following is heavily utilized is the futures arena. Many global macro hedge funds and commodity-trading advisors (CTAs), such as John Henry and Bill Dunn, have been using trend-following systems on futures for years, amassing billions of dollars under management. While futures trend-following is quite a different strategy than what is detailed in this paper, Mulvey, Simsek, and Kaul (2003) break down the total return of a futures trend-following strategy into its component parts. The return consists of collateral yield (cash sitting in T-bills), trend-following gains, and rebalancing gains in order of return contribution. They assert that collateral yield is the largest chunk of return, a point often overlooked.

APPENDIX B – S&P 500 & Timing Returns by Decade

1900s	S&P 500	TIMING
Return	9.93%	13.81%
Volatility	12.65%	9.20%
Sharpe	0.41	0.98
Maximum Drawdown	(34.06%)	(9.18%)
T-bills	4.76%	4.76%
1910s	**S&P 500**	**TIMING**
Return	4.35%	7.51%
Volatility	11.91%	8.72%
Sharpe	-0.02	0.33
Maximum Drawdown	(27.90%)	(10.18%)
T-bills	4.64%	4.64%
1920s	**S&P 500**	**TIMING**
Return	14.78%	18.13%
Volatility	16.36%	13.94%
Sharpe	0.67	1.02
Maximum Drawdown	(33.44%)	(23.45%)
T-bills	3.88%	3.88%
1930s	**S&P 500**	**TIMING**
Return	(0.47%)	3.15%
Volatility	37.98%	16.97%
Sharpe	-0.03	0.15
Maximum Drawdown	(79.84%)	(30.63%)
T-bills	0.64%	0.64%
1940s	**S&P 500**	**TIMING**
Return	8.99%	5.52%
Volatility	16.11%	13.63%
Sharpe	0.53	0.37
Maximum Drawdown	(28.12%)	(34.74%)
T-bills	0.47%	0.47%
1950s	**S&P 500**	**TIMING**
Return	19.26%	17.40%
Volatility	11.92%	11.42%
Sharpe	1.44	1.34
Maximum Drawdown	(15.05%)	(14.99%)
T-bills	2.05%	2.05%

APPENDIX B Continued – S&P 500 & Timing Returns by Decade

1960s	S&P 500	TIMING
Return	7.76%	7.12%
Volatility	12.11%	8.89%
Sharpe	0.30	0.34
Maximum Drawdown	(22.25%)	(12.79%)
T-bills	4.07%	4.07%
1970s	**S&P 500**	**TIMING**
Return	5.88%	8.40%
Volatility	15.99%	10.85%
Sharpe	-0.04	0.18
Maximum Drawdown	(42.64%)	(15.88%)
T-bills	6.50%	6.50%
1980s	**S&P 500**	**TIMING**
Return	17.55%	15.27%
Volatility	16.39%	14.46%
Sharpe	0.51	0.42
Maximum Drawdown	(29.58%)	(23.26%)
T-bills	9.23%	9.23%
1990s	**S&P 500**	**TIMING**
Return	18.21%	13.09%
Volatility	13.43%	12.04%
Sharpe	0.98	0.67
Maximum Drawdown	(15.37%)	(16.47%)
T-bills	4.98%	4.98%

2000s	S&P 500	TIMING
Return	-0.94%	7.73%
Volatility	16.13%	8.27%
Sharpe	(0.23)	0.61
Maximum Drawdown	-50.95%	-6.82%
T-bills	2.72%	2.72%

APPENDIX C – BEHAVIORAL BIASES

Humans display all sorts of behavioral biases that muck up our chances for investment success. Remember piling into the dot-coms in the late 1990s only to sell them in 2003? You're not alone; investors love to herd into an asset class at the top and sell at the bottom. Stock funds accounted for 99% and 123% of mutual fund flows in 1999 and 2000. People were selling off their other holdings to plow money into stocks. Reported mutual fund returns are almost always higher than individual investor returns due to this poor timing.

From 1973 through 2002 NASDAQ stocks gained 9.6% per year, but because most investors pumped in money from 1998 through 2000, the typical dollar invested earned only 4.3% a year (Dichev 2007). Tale after tale of irrationality in financial markets can be found in Charles Mackay's *Extraordinary Popular Delusions and the Madness of Crowds* and Charles Kindleberger's *Manias, Panics, and Crashes*".

The field known as behavioral finance was founded in the 1970s to study these phenomena as applied to financial markets. Professors Amos Tversky and Daniel Kahneman did much of the early work. While there are dozens of documented ways in which people are irrational when it comes to money, here are some of the more insidious biases:

Overconfidence - 82% of drivers say they are in the top 30% of drivers, and 80% of students think they will finish in the top half of their class (Tilson 2005).

Information overload - More information often decreases the accuracy of predictions, all the while increasing confidence in those predictions. Paul Andreassen, a psychologist formerly at Harvard University, conducted a series of laboratory experiments in the 1980s to see how investors respond to news. He found that because of excessive trading people who pay close attention to news updates actually earn lower returns than people who seldom follow the news.

Herding - From 1987 through 2007, the S&P returned over 10% per year. However, the average investor in a stock mutual fund earned only 4.48%. That means that over these past 20 years, the average equity mutual fund investor would have barely kept up with inflation (DALBAR 2008).

Avoiding losses - People feel the pain of loss twice as much as they derive pleasure from an equal gain (Tversky 1979). Over forty years ago in *Common Stocks and Uncommon Profits* Philip Fisher wrote, "There is a complicating factor that makes the handling of investment mistakes more difficult. This is the ego in each of us. None of us likes to admit to himself that he has been wrong… More money has probably been lost by investors holding a stock they really did not want until they could "at least come out even" than from any other single reason."

Anchoring - During normal decision-making, individuals anchor (or overly rely on) specific information or a specific value and then adjust to that value. Once the anchor is set, there is a bias toward that value. Warren Buffet laments: "When I bought something at X and it went up to X and 1/8th, I sometimes stopped buying, perhaps hoping it would come back down. We've missed billions when I've gotten anchored. I cost us about $10 billion (by not buying enough Wal-Mart). I set out to buy 100 million shares, pre-split, at $23. We bought a little and it moved up a bit and I thought it might come back a bit –who knows? That thumb-sucking, the reluctance to pay a little more, cost us a lot" (2004 Berkshire Hathaway annual meeting).